AMAZONIANA	II	3	257—352	Kiel, März 1970

(From: Cooperation between Max-Planck-Institut für Limnologie, Abt. Tropenökologie, Plön, Germany, and Instituto Nacional de Pesquisas da Amazônia, Manaus-Amazonas, Brazil)

Food of Central Amazonian Fishes*)

Contribution to the nutrient-ecology of Amazonian rain-forest-streams

by HANS-Armin KNÖPPEL

The black- and clear-waters in the Rio Negro-region are evident poor in soluble minerals. There have been no studies, till now, on the effect of this poverty on the productivity in these rain-forest-streams.

Generally one may suppose that primary production is handicapped, or perhaps even prevented, by the lack of nutrients and the lack of light, due to the black colour of the water and the compact leafy roof. And consequently the important first link of the food chain would be absent. Still, the top link of the food chain is evident: the fishes. They often are observed in large numbers.

This paper deals with the question: What do the fishes eat? As a first contribution, the stomach contents of fishes from central Amazonian rain-forest-streams are reported.

The knowledge in Amazon fishes essentially is restricted to their morphology, and rarely to their anatomy or physiology.

Some ecological data concerning fishes are given by LÜLING, 1961, 1963, MARLIER, 1967, and GEISLER, 1967. Recently GEISLER, 1969, got some data on oxygen tension in the Rio Negro from which he got some idea of the fishes' ecology. For the first time, a big collection of material is available, and forms the basis of the present contribution.

1. Material

The material studied was collected in the Brazilian Amazon region some years ago. In 1965 Dr. E.-J. FITTKAU of Plön, at the behest of Sioli, caught the fishes. The primary aim of Dr. Fittkau's expeditions was to study the systematics and ecology of chironomids. By his remarkable activity he succeeded in removing the fishes from creeks at several localities at various times. In 1967 Mr. W. Junk was kind enough to catch supplementary fishes at the same localities.

Each brook was blocked by fishing nets (mesh-width: 2 mm). The poison rotenone, put in 100—200 metres above, killed all fishes in this section of the creek quickly.

*) Brazilian contribution to the International Biological Programme, Section PFM; Contribuição brasileira ao Programa Biológico Internacional, Secção PFM.

Rotenone is a rapidly acting nerve poison which, dissolved in aceton, was distributed by the current. One may suppose that at least all fishes which do not burrow into the bottom were killed by the poison. Several assistents collected the dead fishes as quantitatively as possible.

Collecting the fishes is extremely difficult, because many fallen trees and branches lie littered about the channels of the creeks-floor. In black-waters, the fishes elude observation by fleeing into deeper, intensively brownish-coloured water.

The collected fishes are immediately preserved in 4—10% formalin. Fixing in formalin is very useful. It has not only of advantages of carrying less quantities of preservative, but also the good condition of the fishes in colouration and firmness was excellent, even at time of preparation 2—3 years later. Only to simplify treatment were the fishes put into alcohol.

Dr. Fittkau took his samples during the "dry season" in October/November 1965, when the water level was still sinking. Mr. Junk made efforts to collect during the "rainy-season", at higher water-level, in May 1967 at the Igarapé Barro branco, and in July 1967 at the Igarapé Tarumã. But allowance must be made for the fact, that the water-levels in the rain-forest-streams follow the daily rainfalls much more than the seasonal oscillations of the great rivers.

Nevertheless, this method of sampling yielded a large return. By collecting only 5 times at three localities (described below) more than 3200 fishes from 53 species were caught. The result of sampling (Table 1) in these streams around Manaus establishes two points:

Table 1. Numbers of fishes collected in the years 1965 and 1967 (a total of 3216 individuals)

		Tarumã		Barro Branco		Lago Calado
		1965	1967	1965	1967	1965
Characoidei	(22 species)	180	105	105	89	1 363
Gymnotoidei	(6 species)	136	48	56	13	15
Siluriformes	(7 species)	59	29	21	15	6
Cyprinodontoidei	(1 species)	—	14	—	—	—
Percoidei	(17 species)	105	185	141	22	509
53 species:		480	381	323	139	1 893

1. Fishes are abundant in the number of individuals.

From short segments of the creeks with small widths and depths, 2682 fish-specimens (in the year 1965) were caught, in spite of the difficulties mentioned. (Comparable information about the number of fishes in British-Guiana were given by Lowe (Mc Connell), 1964.)

2. Fishes are abundant in the number of species.

The 17 species collected from Igarapé Barro branco (Table 2), and the 41 species from Igarapé da Alegria, Lago Calado (Table 3) come up to Myers', 1960, expectations, that around Manaus alone 700 species can be found. (The mere 6 species from Igarapé Tarumã may reflect the limitations of the special topographical conditions.) This number is notably higher than in comparable tropical river-systems (Ganges, Congo, Niger).

Table 2. Fish species collected in the Igarapé Tarumã and the Igarapé Barro branco; their numbers and weights (in grams)

Igarapé Tarumã

	1965		1967	
	number	weight	number	weight
Hoplerythrinus unitaeniatus	—	—	33	310
Pyrrhulina brevis	180	280	72	120
Gymnotus anguillaris	136	660	48	190
Callichthys callichthys	59	780	29	250
Rivulus "urophthalmus"	—	—	14	—
Aequidens tetramerus	105	2 520	186	4 370
6 species:	480	4 240	382	5 240

Igarapé Barro branco

	1965		1967	
	number	weight	number	weight
Acestrorhynchus falcatus	1	10	—	—
Bryconops inpai	42	400	62	580
Hyphessobrycon bellotti	—	—	23	5
Pyrrhulina brevis	52	100	4	8
Hoplerythrinus unitaeniatus	10	180	—	—
Gymnotus anguillaris	45	300	2	5
Gymnorhamphichthys hypostomus	9	50	—	—
Gymnotus carapo	2	10	—	—
Sternopygus macrurus	—	—	7	10
Steatogenes elegans	—	—	4	—
Callichthys callichthys	2	50	—	—
Helogenes amazonae	4	15	2	5
Rhamdia sp.	11	750	12	850
Loricaria sp.	4	30	1	8
Aequidens tetramerus	133	1 370	18	185
Crenicichla johanna	2	90	—	—
Crenicichla saxatilis	6	35	4	25
17 species:	323	3 420	139	1 650

2. Localities

The studied material was collected at three sites in the country around Manaus, Brazil (Estado do Amazonas), Fig. 1.

1. Igarapé Tarumã, a typical stream of the black-water type[1]) (Table 4).

The point of sampling was 25 km away from Manaus, on the road to the Ponta negra, which is a branch of the road to Itacoatiara. Here the Tarumã is a 2—3 m wide rivulet running on bed rock of the "Formation Manaus" through the high forest of the terra

[1]) The types of black-waters, clear-waters, and white-waters were established by Sioli, 1950, 1965.

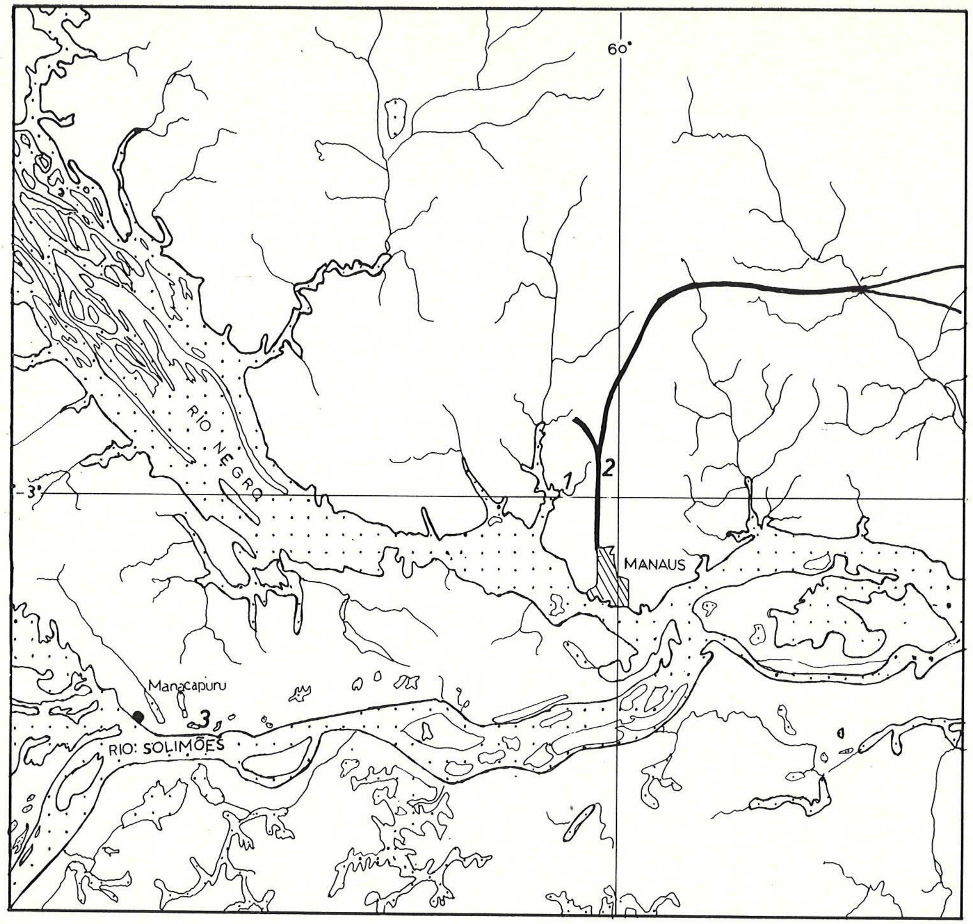

Fig. 1: Environment of Manaus (scale 1 : 500 000).
Igarapé Tarumã (1), Igarapé Barro branco (Reserva Ducke) (2), Lago Calado (3).

firme before it falls 15—20 m into the runoff to the Rio Negro. This Tarumã mouth is seasonally dammed by the Rio Negro water. But at no time does water from the Rio Negro reach the sampling point above the waterfall. Perhaps this may explain the relative poverty of the fish-species in those samples.

2. Igarapé Barro branco, a typical stream of the clear-water type (Table 4).

The Igarapé Barro branco runs as a small brook through the "Reserva ducke", the research area of I. N. P. A. in the high forest of the terra firme. (About 30 km away from Manaus on the road to Itacoatiara, Fig. 1.) The sandy ground of the brook is maximally 1 m wide and the depth is less than 50 cm. The water is transparent and without colouration.

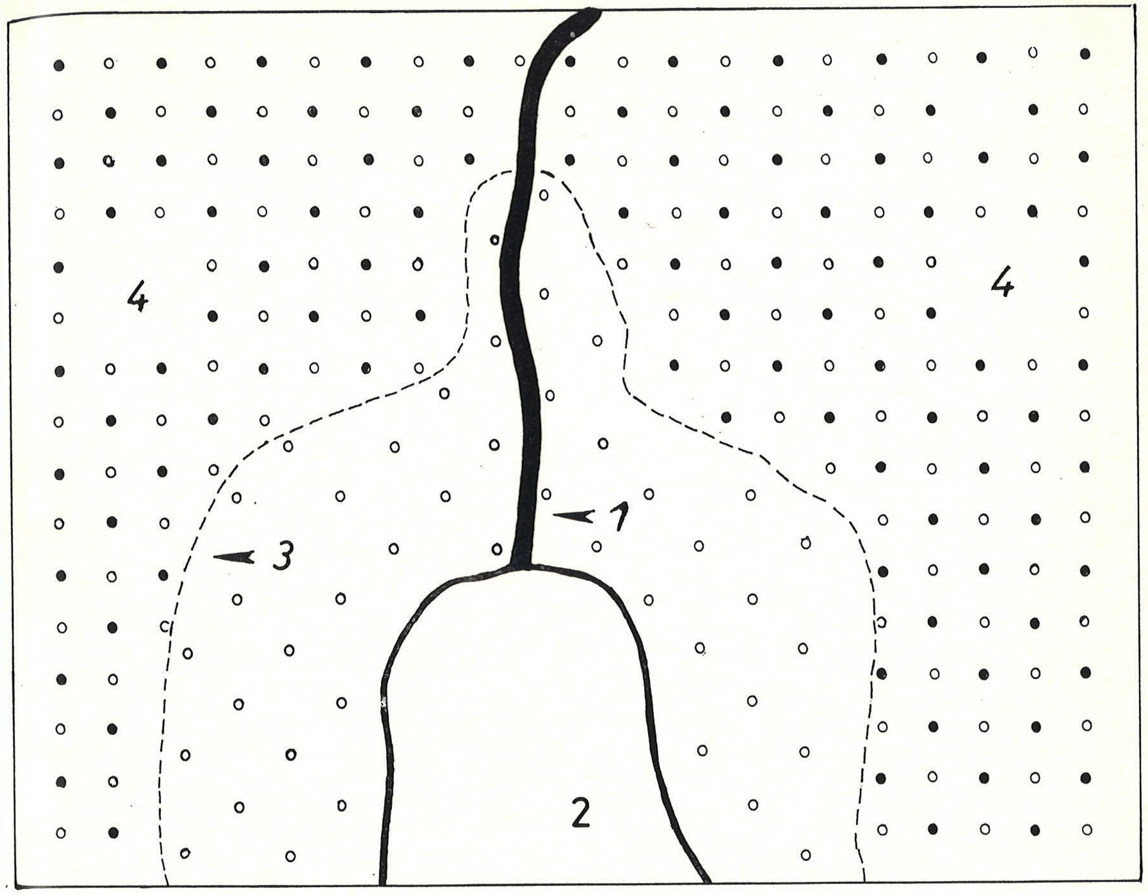

Fig. 2: Igarapé da Alegria; mouth at Lago Calado during low water level.
Ig. da Alegria (1), Lago Calado (2), shore line of the Lago Calado at time of high water level (3), terra firme (4).

3. Brook in the Lago Calado (Igarapé da Alegria), a rivulet (some kilometres) of the clear-water type, which is temporarily flooded by the white-water of the Solimões (Table 4).

At time of sampling, November, this part of the Lago Calado is always draining. The now open ground of the lake is covered by grasses and formerly floating plants, and forms the banks of the clear-water rivulet (Ig. da Alegria) running from the terra firme. The sun can reach the sheet of water without hindrance.

The Lago Calado fills when the Solimões-water is rising, and this lower course of the Ig. da Alegria is drowned (Fig. 2).

Lago Calado is a typical lake of the varzéa (Sioli, 1957 b), and located on the Solimões ca. 100 km above Manaus (below Manacapurú).

Table 3. Fish species collected in the Lago Calado (Ig. da Alegria), their numbers and weights (in grams)

Lago Calado

	1965 number	weight
Brycon melanopterus	22	4 960
Iguanodectes tenuis	5	5
Bryconops affinis	2	20
Hemigrammus ocellifer	197	70
Hyphessobrycon bellotti	562	200
Moenkhausia ceros	25	20
Moenkhausia lepidura	65	90
Megalamphodus micropterus	75	20
Hoplias malabaricus	10	120
Poecilobrycon eques	1	—
Poecilbrycon unifasciatus	96	25
Copella nattereri	138	10
Leporinus friderici	15	6 700
Chilodus punctatus	3	40
Curimatus latior	1	5
Curimatus spilurus	8	5
Prochilodus theraponura	1	5
Crenuchus spilurus	137	90
Gymnotus carapo	4	320
Eigenmannia macrops	2	—
Steatogenes elegans	9	5
Ancistrus sp.	2	45
Pseudancistrus	3	220
Pterygoplichthys sp.	1	25
Monocirrhus polyacanthus	2	10
Cichla ocellaris	2	730
Chaetobranchus flavescens	1	260
Aequidens tetramerus	5	185
Acaronia nassa	185	2 420
Acarichthys heckelii	11	85
Geophagus jurupari	64	590
Apistogramma agassizii	16	8
Crenicichla johanna	11	400
Crenicichla lugubris	24	4 950
Crenicichla nanus	43	180
Crenicichla notophthalmus	24	35
Crenicichla ornata	8	420
Crenicichla saxatilis	24	190
Cichlasoma festivum	106	1 170
Cichlasoma severum	9	290
Uaru amphiacanthoides	1	100
41 species:	1 893	24 980

Table 4. Chemical and physical data from the waters of the Ig. Tarumã, Ig. Barro branco, and the Lago Calado.

All weights µg/l, if not otherwise marked; transparency calculated according to ZIMMERMANN, 1967 (E 10/420 nm). The given data for the Lago Calado show that white water from the Solimõe, and clear water from the terra firme (see Fig. 3) have been mixed; at the locality where the fishes were taken the data for the water were in accordance with those for the Ig. Barro branco.

	Tarumã	Barro branco	(Lago Calado)
colour of water	brownish	colourless	—
transparency, mg Pt/l	200.0	39.0	—
turbity, mg	0.016	0.016	—
temperature, °C	—	24	30
conductivity, μS_{20}	25.5	9.5	38
p H	4.1	4.4	6.4
$KMnO_4$ — oxidability, mg/l	117.6	29.5	23.1
diss. O_2, mg/l	6.6	6.3	—
N (NH_4)	51.3	*)	—
N (NO_2)	0.5	0.76	0.8
N (NO_3)	1.1	37.9	2.1
N (Kjeldahl)	160.0	*)	—
N, total	212.4	38.7	118.0
N, organ. (calculated)	108.7	*)	—
P, total	9.7	6.5	—
P (PO_4)	7.3	4.1	—
Fe, total	180.5	53.4	210.4
Fe, diss.	138.0	53.4	188.4
Fe, undiss.	42.5	—	—
Ca	20	20	2 411.1
Mg	10	10	3 607.2
Total hardness	ñ)	*)	—
Cl, mg/l	2.0	2.0	1.2
Si (diss. SiO_2)	139.0	203.0	—
alkalinity, mval/l	*)	0.05	3.5
Mn	5.3	*)	—
Al	4.3	*)	—

*) = trace only

So fishes of this locality cannot be simply allied to a certain type of water. On the one hand, fishes of the lake may take refuge in the clear-water of the rivulet, when Lago Calado becomes more and more dry and warm. On the other, fishes of the terra firme may live there. Also we cannot yet say anything about the whereabouts of those fishes when the white-water is rising.

3. Methods

The collection of material is worked up in this manner. Each fish species is separately reported, not only their meristic data but also their stomach contents. The results of all fishes are then discussed, and the limnological importance is brought out.

Taxonomic and systematic comments on the studied material are not the essential aim in this paper, but the determination of the fish species is a prerequisite for description of their ecology. The detailed meristics, which are nevertheless introduced, are intended as a contribution to the knowledge of the Brazilian fishes.

Table 5. The number of empty and full stomachs. The food is related to the volume of the stomach sac by 5 categories: empty (A), quarter-full (B), half-full (C), threequarter-full (D), full (E); S = sum)

	A	B	C	D	E	S
Igarapé Tarumã						
Hoplerythrinus unitaeniatus	6	6	4	3	2	21
Pyrrhulina brevis	10	26	46	23	5	110
Pyrrhulina brevis (1967)	—	13	24	14	2	53
Gymnotus anguillaris	5	47	45	16	1	114
Callichthys callichthys	10	24	11	5	5	50
Aequidens tetramerus	—	13	50	12	2	77
Aequidens tetramerus (1967)	—	6	41	24	2	73
Igarapé Barro branco						
Bryconops inpai	—	4	16	8	4	32
Hyphessobrycon bellotti	—	1	10	3	—	14
Pyrrhulina brevis	1	4	10	15	12	42
Gymnotus anguillaris	4	7	14	5	3	33
Rhamdia sp.	—	2	5	4	1	12
Rhamdia sp. (1967)	—	1	8	2	—	11
Aequidens tetramerus (1967)	—	1	15	2	—	18
Aequidens tetramerus	—	13	41	16	9	79
Lago Calado						
Brycon melanopterus	5	6	4	1	—	16
Hemigrammus ocellifer	3	12	15	9	—	39
Hyphessobrycon bellotti	4	9	14	7	—	34
Moenkhausia ceros	—	8	8	1	1	18
Moenkhausia lepidura	—	6	6	3	—	15
Megalamphodus micropterus	1	3	4	3	—	11
Poecilobrycon unifasciatus	—	—	6	10	—	16
Copella nattereri	—	1	10	7	—	18
Leporinus friderici	2	4	5	2	—	13
Crenuchus spilurus	3	11	9	2	—	25
Acaronia nassa	3	4	19	5	—	35
Acarichthys heckelii	—	1	4	6	—	11
Geophagus jurupari	1	1	20	5	1	28
Apistogramma agassizii	—	—	8	4	—	12
Crenicichla lugubris	4	8	2	—	—	14
Crenicichla nanus	3	4	9	4	1	21
Crenicichla notophthalmus	2	4	5	6	—	14
Cichlasoma festivum	—	4	28	14	—	46
	67	251	516	241	46	1 121
	6%		94%			100%

In the taxonomic part both the scientific name with author and year of description and the common name are given, if available. In addition the number of the fishes at hand from each locality is given, and in brackets, the number of fishes, which were counted and measured to identify the species.

The counts and proportions are derived in the usual manner. The proportions are always based on the standard length (sd. l.) or the length of the head, unless there are peculiarities to be mentioned.

The investigations of the stomachs are essential to this study. The fishes were cut with shears in such a way, that the entire stomach and intestine could be removed. The length of the intestine was measured and related to the standard length (Table 43—47). If a stomach could be recognized easily, only the contents of that were counted. In fish species without a distinct stomach, the contents of the complete digestive tract were investigated.

All food items were counted as the stomach contents which were washed out, with great care, when the stomach was opened in a small basin filled with alcohol. The food was analysed under a binocular and microscope.

Complete, less digested animals or plants in the guts were counted individually. Sometimes one can deduce the number of food combining the single parts. Naturally, counting was stopped where digestion had reduced the food to very small pieces whose origin only approximately determined (number method).

For quantitative inventory of all still distinguishable food items their percentage of the stomach contents was assessed. In that case the volume of food was taken as 100%, regardless of the volume of the stomach (volume method).

In a special table (Table 5) the extents to which the stomachs were filled is categorized.

In addition, the number of fishes in which each food item occurred, is listed as a percentage of the total number of fishes examined (occurrence method). This method indicates the importance or accidentalness of a food item for the nutrition of fish.

The various methods of enumerating the food of fishes were reviewed and discussed by Hynes, 1950. As shown above, in this paper several methods are used in tabulating quantitative data on Amazonian fishes' food: The number method, the volume method, and the occurrence method.

The food is presented as "mean stomach contents". In it, the mean value of the numbers and volumes of the food items per fish are listed. (From all stomachs examined the individual counts and assessments were summed and divided by the number of stomachs to get the mean value of each food item.)

Analyses of the food give information about the fishes' diet, and an idea of the food supply.

It is presented so as to reflect the diversity of available food, hence the food is separated into items as much as possible. By this, an overhasty interpretation is prevented, which doubtless would happen if more inclusive categories for food items were used. So the animals and plants in the guts are carried down to their systematic orders or to particular ecological characteristics.

By listing the food items in the specific order shown in the tables (Table 6—47) the origin of the animals and plants is suggested. At the top those items are listed with clearly allochthonous origin (Formicoidea); at the end, the clearly autochthonous items (fishes, Crustacea) are listed. Between them there are those items (coarse litter, detritus) for which origin cannot be clearly determined.

In the following, the individual food items are defined and listed in the order in which they occur in the tables (Table 6—47).

1. Formicoidea: All ants found, the part of Myrmicidae is mostly bigger than the part of Formicidae, often winged forms.
2. Hymenoptera: Excepting ants, single bees, often wasps.
3. Isoptera: All termites, mostly forms without eyes.
4. terr. Coleoptera: All terrestrial beetles.
5. Diptera: All midges and flies, including subimaginal stages.
6. Arachnea: Spiders (not differntiated into aquatic and terrestrial forms).
7. fruits: Granulous, solid fruits or seeds, not of aquatic origin.
8. coarse litter: Pieces of wood or dead leaves and stems, mainly eaten from the bottom.
9. plant matter: Including all semidigested remains only recognizable as plant origin; (sometimes moss, but very rarely).
10. chitinous remains: Semidigested remains of arthropods (they are, probably, derived from the Crustacea and Insecta which were found).
11. detritus: This remains are reduced to small pieces so much, that their vegetabile or animal origin is not clear. Possibly, they are the gut contents of the animals found.
12. aquat. Coleoptera: All beetles adapted to the aquatic environment by their morphology.
13. Hemipteroidea: All bugs and cicadas.
14. to 19. Larvae of insects, all living in the water.
    - 14. Ephemeroptera: Several species, among them are forms which dig in the sand and predatory ones.
    - 15. Odonata: Mostly species with larger larvae; nymphs too.
    - 16. Trichoptera: Several species, mostly eaten with the granulous cases.
    - 17. Lepidoptera: Only in small numbers.
    - 18. Coloptera: Elminthidae are predominant.
    - 19. Diptera: Almost exclusively chironomids, a few ceratopogonids.
20. sand: Sand grains and mud, fractions only significant in curimatid fishes.
21. algae: Filamentous algae or diatoms.
22. Hydracarina: Very small, mostly their fraction of the volume is less than 5%.
23. Crustacea: Copepoda, Ostracoda, and Decapoda are found, often a large number of ephippia.
24. fishes: Smaller fishes (characids, cichlids), fish flesh or scales.

Other, unusual items are indicated in comments in the text.

The tables (Table 6—47) which are used for the description of the mean stomach, follow a constant pattern. There are two parts:

A. Mean stomach contents

(1) All food items are listed, which were found in the stomachs at all named localities. They may represent the food supply.

(2) The numbers of each item present, if counting was possible (number method).

(3) The percentage of the food's volume, in relation to the whole stomach contents (volume method). The figure after the decimal illustrates that the data are calculated as mean values. For discussion it is not important.

(4) Illustration of the volume percentage; the line at top equals 50%. (Values less than 5% are marked with a cross.)

B. Occurence of food items

(5) The number of fish in which each food item occurs (occurrence method).

(6) The percentage of the total number of fishes examined in which each food item occurs; stomachs without contents inclusively.

At the end of the table the name of the fish species, the locality and the number of stomachs examined (indiv.) are given, as well as the lengths of the fishes. (The stomach contents are given only in the text if there were less than 10 individuals o fa fish species.)

Taxonomy and Stomach Contents

In the following section, the collected fish species are separately described with their meristic data and their stomach contents. The fishes are put in systematic order. For this the studies of many authors are taken as a basis. (L. S. Berg, 1955, Gery, 1961, 1963, Gosline, 1966, Greenwood et. al., 1966, Regan, 1905, Weitzman, 1962, 1966)

The Brazilian common names are taken from Fowler, 1948—1954, R. S. Menezes, 1948, or from personal communications.

When listing the taxanomic data, always the same abbreviations are used[1]).

[1]) Abbreviations used in the taxonomic descriptions:

sd. l. = standard length; depth = depth of the body; head = length of head (without membrane); eye = diameter of eye (vertical); i. o. = width of the bony interorbital; snout = length of the snout; maxillary = length of the maxillary; sn-D/D-C = ratio of the distance snout-dorsal fin to the distance dorsal-caudal fin.

D = rays of dorsal fin; A = rays of anal fin; P = rays of pectoral fin; V = rays of ventral fin; C = caudal fin.

sc. = scales; sc. lat. = lateral line; sc. longit. = longitudinal series from operculum to caudal basis; sc. transv. = series from dorsal fin to ventral; sc. predors. = series between dorsal and occiput; sc. pecuncle = round the peduncle.

teeth: mx. = maxillary; dn. = dentary; pmx. = premaxillary; int. = internal row of teeth; ext. = external row of teeth.

1. CHARACOIDEI

a. Characidae

1. Characinae

(1) *Acestrorhynchus falcatus* (Bloch, 1794)

Peixe-cachorro; 1 specimen — Ig. Barro branco.

Sd. l. 125 mm. Depth 5.0, head 3.5 in sd. l.; eye 3.6, i. o. 5.1, snout 2.8, maxillary 3.2 in the head. D ii 9, A iv 23 (i). Sc. lat. 87 (3), sc. transv. ?/1/10; mx. teeth 9, dn. teeth 7. Colouration: humeral spot large, rounded, dark; caudal spot produced to the end of the middle caudal rays.

Stomach contents: 1, empty.

2. Bryconinae

(2) *Brycon melanopterus* (Cope, 1871)
22 specimens (14) — Lago Calado.

Sd. l. 194—266 mm. Depth 3.0—3.4, head 3.4—4.2 in sd. l.; eye 3.3—4.3, i. o. 2.0—2.4 in the head. Sn-D/D-C 0.8—0.9. D ii 9, A iii 23—25 (i). Sc. predors. 24—28, sc. lat. 61—18, sc. transv. 14/1/9—12. Gill rakers 9/9. Pmx. teeth in 3 series, the middle one irregular; 12 ext. pmx. teeth; 9 very small mx.-teeth; dn. teeth in 2 rows, ext. with 4—5 quincuspid and 4 smaller conical teeth, int. row only with smaller teeth, which are irregular at the symphysis. Colouration: a black band extends along the anal basis to the caudal spot, which is produced to the upper lobes of the caudal fin.

Stomach contents: 16, 5 empty.

The food was composed mainly of plant matter (70%), with a significant fraction of coarse litter, recognizable by the rotten leaf veins and stem segments. One fish each had eaten ants, scales or fruits. All the other stomachs were more or less completely filled by plant remains from the bottom (Table 6)[1].

Brycon melanopterus ingested coarse litter.

3. Iguanodectinae

(3) *Iguanodectes tenuis* Cope, 1871

5 specimens (5) — Lago Calado.

Sd. l. 33.3—45.8 mm. Except for the number of gill rakers, 7, the counts and proportions agree with Eigenmann & Myers, 1929: 494.

Stomach contents: 5, none empty.

The few examined specimens were exclusively filled with plant matter. Important items were filamentous algae and diatoms. One cannot say certainly whether these were eaten actively or picked up clinging to the coarse litter or detritus.

4. Tetragonopterinae

(4) *Bryconops affinis* (Günther, 1864) Knöppel, Junk, Gery, 1968
2 specimens (2) — Lago Calado.

Sd. l. 76.8—77.6 mm. Depth 3.6, head 4.1 in sd. l.; eye 2.4, i. o. 2.8 in the head. Maxillary reaching the suture SO_2/SO_3. A iii 25—28. Scales of the melanurus/affinis — type (Knöppel et al., 1968), sc. lat. 45—46, sc. transv. 7/1/3—4, sc. predors. 11. Ext. pmx. teeth 3—4; int. pmx. teeth 5; 1—2 mx.

[1]) Table 6—42; the legend for these tables is the same, and is given in the text, see page 266/7

teeth; 5—6 quincuspid plus some more very small dn. teeth. Gill rakers 9/6. Colouration: as in many juvenile forms, a dark band from gill cover to peduncle.

Stomach contents: 2, neither empty.

In both stomachs only allochthonous food items were found: 1 ant, 1 whip-tailed scorpion (Amblypygi), 1 cockroach (Blattoidea), 1 mayfly (imago ?). This result corresponded to the data of Alexander, 1964 (fishes from British Guiana).

(5) *Bryconops inpai* Knöppel, Junk, Gery, 1968
104 specimens (42) — Ig. Barro branco.

In addition to the 42 specimens at hand for the original description Mr. W. Junk was able to collect more specimens at the same locality, two years later. Among them were also some juvenile forms.

Stomach contents: 18, 1 empty.

In the stomachs the individual fragments of the ants were easily recognizable. Some individuals could be determined to genus (Camponotus — Formicidae, Stronylognathus — Myrmicidae). Often the individuals were preserved whole.

This species, abundant in the Ig. Barro branco, had predominantly eaten ants (32%), termites (12%), and other terrestrial insects, which made up 28% altogether. Fruits and plant matter made up a volume of 12%; probably, the solid fruits were allochthonous origin. In single specimens, the occurrence of green filamentous algae, moss thalli, and diatoms was noted. Two lice (Psocoidea) and a down feather were not listed in the table (Table 7).

There were ants in 95% of the stomachs examined, and termites in 60%.

This result was verified completely by the May, 1967 collection. 32 stomachs examined. Ants made up a volume of 43%, termites 9%. They occurred in 87% and 22% of the fishes examined. Occuring in 25% of the fishes Diptera, fruits and Ephemeroptera nymphs were also considered to be frequent constituents. Nevertheless their volume percentage each remained below 5% (Table 8).

Bryconops inpai ingested ants (and other terrestrial insects).

(6) *Hemigrammus ocellifer* (Steindachner, 1882)
197 specimens (15) — Lago Calado.

Sd. l. 14.1—38.2 mm. Depth 2.4—3.0, head (2.8)—3.8 in sd. l.; eye (2.0)—3.0, i. o. 2.3—3.0 in the head. A iii—iv 18—24 (i). Scales predors. 10 (in one specimen 11), sc. longit. 26—28 (plus 2—3 scales on the caudal fin). Gill rakers 6/10—11. Mx. teeth 1—2 (never 4), mostly 2.

Stomach contents: 39, 3 empty.

Digestion had proceeded to different stages. Often one could still observe the total animals or fruits in the guts, but the contents were mostly reduced to very small pieces.

The food was composed of many items.

Nevertheless the fraction of ants (23%) and the plant matter (24%, including 7% fruits and seeds, seemed to be important. On account of the great degree of digestion, many unrecognizable pieces of insects and plants must be indicated as detritus (12%).

Thus, ants and plant matter were most frequent, each item in 33% of the stomachs examined. They must be counted among the regularly ingested food items (Table 9).

Hemigrammus ocellifer ingested ants and plant matter.

(7) *Hyphessobrycon bellotti* (STEINDACHNER, 1883)
562 specimens (13) — Lago Calado; 23 specimens — Ig. Barro branco.

Sd. l. 17.2—37.5 mm. The collected specimens were in excellent accordance with respect to their meristics to those fishes reported from the upper Rio Negro and the upper Amazon (Ig. Préto) by GERY, 1963c, 1965a. (Depth 3.4—4.4, head 3.3—4.7 in sd. l. A iii—iv 17—20. Scales 5/(6—7) 31/5. Gill rakers 7—8/10—11. Mx. teeth 0—1.)

Stomach contents:

Ig. Barro branco (1967) — 14, none empty. The food items well separated in the stomachs, were easy to identify. Only a few items were present: larvae of Ephemeroptera (30%), some trichopteran and chironomid larvae. Conspicuously, the largest percentage of volume was Formicoidea (31%). In addition, there were smaller numbers of Isoptera and Arachnea.

The large fraction of chitinous remains (22%) can be explained easily, since the food consisted exclusively of arthropods. This was also shown in the abundance of the food items. Ants or Ephemeroptera were to be found in every other stomach (Table 10).

Lago Calado — 34, 4 empty. Single animals in the guts were frequently found together with a lot of unidentifiable material (plant matter, chitin, detritus). In particular, the larvae of insects were found together with detritus or plant matter, which may originate from the coarse litter on the bottom. Formicoidea and other Hymenoptera were nearly always found singly in the stomachs.

The stomach contents consisted of many items which were not always easy to identify. The fractions of plant matter (18%), of chitinous remains (11%), and of detritus (19%) were biggest. Clearly distinguishable animals in the guts mostly made up a percentage of less than 10% (Ephemeroptera, Trichoptera, and Lepidoptera larvae, and subimaginal stages of aquatic Hemipteroidea. The percentage of Formicoidea (8%) and Hymenoptera (6%) was considerable.

The frequency of stomachs in which a specific food item occurred corresponded to the volume percentage (Table 11).

Hyphessobrycon bellotti ingested nearly exclusively Ephemeroptera and Formicoidea in Ig. Barro branco; in Lago Calado, for the most part, they ingested larvae of insects and detritus as well as plant remains, as well as a few Formicoidea.

(8) *Moenkhausia ceros* EIGENMANN, 1908
25 specimens (9) — Lago Calado.

Sd. l. 31.9—36.8 mm. The fishes were typical. Some specimens are known from the Peruvian Amazon (GERY, 1964b).

Stomach contents: 18, none empty.

The stomach contents consisted nearly exclusively of plant matter only determinable as such, and detritus, and occasionally several chitinous pieces were visuable.

Detritus (40%) made up an important proportion, vegetable items altogether made up a volume of 36%. Insects (Hymenoptera, Hemipteroidea, and Ephemeroptera) occurred only separately and more incidentally.

Vegetable fractions and detritus were each found in 75% of the stomachs examined.

The well recognizable coarse litter (14%) permitted a guess that the remaining food items (detritus) originated from the bottom (Table 12).

Moenkhausia ceros ingested predominantly (vegetable ?) detritus and plant matter, especially the coarse litter.

(9) *Moenkhausia lepidura* (KNER, 1859)
65 specimens (16) — Lago Calado.

Sd. l. 33.4—58.4 mm. Depth 3.2—4.0 in sd. l. A iii 21—23. Scales 5/32—33/3.5. Gill rakers 11—14/7—8.

These fishes differ from the type from Rio Guaporé as to the number of scales in the lateral line (32—33), which gives evidence for inclusion in *M. lepidura icae*. GERY, 1965b: 108, however, questioned the differentiation of *M. lepidura* into distinct subspecies, which often were based only on a few variablities in the clouration, and combined the meristic data for the distinct populations.

Stomach contents: 15, none empty.

As in *M. ceros*, the contents were scarcely to be identified. Large fractions of detritus (40%) and plant matter (25%) covered single insects. This occurred only once. But plant matter occurred in 80% and detritus in 60% of the stomachs examined (Table 13).

Moenkhausia lepidura ingested detritus and plant matter.

5. Cheirodontinae

(10) *Megalamphodus* cf. *micropterus* EIGENMANN, 1915
75 specimens (12) — Lago Calado.

Sd. l. 20.1—30.4 mm. Depth 3.2—3.8 (mean 3.6), head 3.4—3.8 in sd. l.; eye and maxillary about 2.5, i. o. 2.7—3.1, snout 3.1—3.5 in the head. D ii 9, A iii—iv 22—24, dorsal fin somewhat nearer to the snout than to caudal. Scales predors. 10 (one specimen with 9), sc. lat. 5—7 perforated plus 23—25 non-perforated scales (altogether 31—35). Gill rakers 7/15. Pmx. teeth 8—11, mostly tricuspid, sometimes 1—3 teeth formed an external row; mx. teeth always 4 (conical ?); dn. teeth: 7 larger tricuspid plus 5 smaller conical ones. Although the depth was significantly smaller (3.2—3.8) and the number of analrays was higher than given for *M. micropterus* (EIGENMANN, 1915: 54), the fishes from Lago Calado were included in this species, because the remaining meristics, especially the number of scales, were in accordance. Till now, a premaxillary tooth standing forward in an external row is only known for *M. micropterus*.

Possibly the present specimens are also to be included in *M. melanotus* (EIGENMANN, 1912), because the low depth and the number of teeth come closer to *M. melanotus*. GERY, 1960, put *Megalamphodus* together with *Pristella* and *Pseudopristella* in close relationship, and put this group in a position in the phylogenesis before the Cheirodontinae sen. str.

Stomach contents: 11, 1 empty.

The contents were nearly always very full of detritus and the chitinous remains were covered by the detritus.

The volume of detritus was 55%. Only incidentally did the fishes eat single larvae or plant matter (Table 14).

Megalamphodus cf. *micropterus* ingested detritus.

b. Erythrinidae

(11) *Hoplias malabaricus* (BLOCH, 1794)
Traira, Dorme-dorma; 10 specimens (9) — Lago Calado.

Sd. l. 59.9—153.2 mm. The present specimens all must be considered juvenile forms (head 2.7—2.8, eye 12—17 in sd. l.; (5.0—5.8 in the head). D iii 11. Scales lat. 39—42. Teeth on the ectopterygoid and palatine; external rows with pointed conical teeth, small and truncated teeth more internal.

Stomach contents: 9, 3 empty.

The two larger specimens only ate fishes (smaller characids about 20—30 mm sd. l.) which gave a percentage of 30% in the mean stomach contents. (Possibly one may add fatty or fleshy fish tissue as an item, which was attributed to those stomachs "empty". The intestines of these fishes could not investigated owing to the runny rottenness.) Nevertheless, the large percentage of food items from near the bottom (70%) eaten by the smaller specimens was surprising: fine sand 20%, coarse litter 32% and plant matter 18% (Table 15).

Hoplias malabaricus ingested as young fish (possibly exclusively ?) coarse litter and sand, and as adult, only fishes.

(12) *Hoplerythrinus unitaeniatus* (SPIX, in AGASSIZ, 1829)
Traira pixuna; 33 specimens (9) — Ig. Tarumã (1967), 10 specimens (3) — Ig. Barro branco.

Sd. l. 43.2—129.4 mm. The individuals from the different localities did not differ in the habitus (colouration, meristics). Maxillary (2.0—2.2 in the head) was very long reaching about the posterior margin of the eye (5.1—6.6 in the head, 22 in sd. l.). Scales lat. 34—35. Colouration was rather similar to *Erythrinus* with the dark, marbled back and some spots on the flank. A longitudinal stripe was not recognizable, but at the caudal basis and the humeral, the young forms especially, had clearly marked spot. Most of the examined specimens were still juvenile forms (smaller than 90 mm sd. l.).

Stomach contents:

Ig. Tarumã (1967) — 21, 6 empty. The food items were nearly always present in individual, whole specimens. The food consisted predominantly of aquatic insect larvae (70%). The larger species (Ephemeroptera 39% and Trichoptera 20%) were preferred, and some Lepidoptera and Coleoptera larvae were also ingested. Plant matter (7%) and fishes (smaller cichlids, 13%) were each found in two individuals. Ephemeroptera larvae (33%) were the most frequent by far. Plant matter, fishes, Coleoptera appeared to have been accidentally ingested, and were not only restricted to the larger individuals (Table 16).

Ig. Barro branco —10, 2 empty. The item of Crustacea (Decapoda, Palaemonidae ?) was very high (45%). Adding three Ephemeroptera larvae (18%) and one aquatic Coleoptera, the vegetable percentage (28%) was scarcely important (Table 17).

Hoplerythrinus unitaeniatus (for the most part juvenile forms) ingested Ephemeroptera larvae and Trichoptera larvae, and occasionally fishes in the Ig. Tarumã; in Ig. Barro branco the decapods (Crustacea) were notable.

c. Lebiasinidae

6. Nannostominae

(13) *Poecilobrycon eques* (STEINDACHNER, 1876)
1 specimen — Lago Calado.

Sd. l. 22.9 mm. According to WEITZMAN, 1966, *P. eques* belongs to the subgenus *Nannobrycon* HOEDEMANN together with *P. unifasciatus*.

Stomach contents: 1, not empty.

Among the brownish detritus (vegetable origin) many bundles of filamentous algae.

(14) *Poecilobrycon unifasciatus* (STEINDACHNER, 1876)
96 specimens (7) — Lago Calado.

Sd. l. 30.8—33.0 mm. These specimens from Lago Calado seemed to be of significantly smaller depth (5.3—6.0 in sd. l.) in contrast to those fishes described by WEITZMANN, 1966.
Also the eye is much smaller (3.4—3.8 in the head). Otherwise the biometric data, the colouration and the dentation were in accordance with the given data (head 3.8—4.1, depth of peduncle 10.8 to 12.0 in sd. l. D ii 8, A iii 9. Scales 28. Gill rakers 8/14). There was an adipose fin on each specimen.

Stomach contens: 16, none empty.

In the soft substances of detritus, mostly brownish or yellowish-coloured, the colourless bundles of algae filaments and plant remains were immediately conspicuous.

Half of the stomach contents were not better determinable detritus (50%). The recognizable remains, reduced into very small pieces of plant stems, leaves or the like came up to 36%. The conspicuous filamentous algae made up 10%. In addition, there were traces of sand and chitin.

In nearly all stomachs examined (in 72% and 87%) plant matter and detritus were found. In every third stomach algae or sand was recognizable (Table 18).

Poecilobrycon unifasciatus ingested plant matter, detritus and algae, as well as sand components.

7. Pyrrhulinae

(15) *Pyrrhulina brevis* STEINDACHNER, 1875
252 specimens (27) — Ig. Tarumã; 56 specimens (8) — Ig. Barro branco.

Sd. l. 12.6—79.1 mm. Depth 3.8—4.6, head 3.7—4.0 in sd. l.; eye 3.4—4.4 (mean 3.8) ♂♂, 3.1—4.1 (mean 3.4) ♀♀, i. o. 2.2—2.9, snout 2.6—3.3 in the head. D (ii) 10, A (iii ?) 11. Scales lat. 21—22 (2—3), sc. predors. 12, sc. transv. 5.5. Teeth in two rows on the premaxillary and dentary, one row on the maxillary. These data were in rather good accordance with the original description. Colouration: ♂♂, margins of the dorsal, ventral, and anal fin narrow, black; a black spot in the dorsal fin.

The clearly marked dark stripe runs from tip of snout to the eye and then, less clear and wider, to the 4th—6th scale of the lateral line. ♀♀, margins of the fins not coloured. Opercula and first scales on the lateral line not specificly marked.

There are only a few reports on finding *P. brevis*. GERY, 1964b: 32—33, considered that *P. lugubris* EIGENMANN, 1922 was identical to *P. brevis*. The specimens examined from Ig. Barro branco verified the meristics of those fishes from Ig. Tarumã which were measured in detail.

Stomach contents:

Ig. Tarumã — 110, 10 empty. The food was well identifiable, because the ants were mostly well preserved. There were often nymphs of Ephemeroptera. Some pieces of moss and algae were counted in the plant matter. More than half of the stomachs were filled by ants, nearly exclusively Myrmicidae, Isoptera, Coleoptera, and Diptera pupae, and Arachnea were present as a small percentage.

Many food items were found, but most were without importance. The vegetabile fraction was extremely small. The probably exclusively animal food consisted predominantly of Myrmicidae (Formicoidea 57%) and other terrestrial arthropods (Isoptera, Hymenoptera, Coleoptera, Diptera pupae, and Arachnea).

On the other hand, there was also a notably great amount of aquatic animals in the guts: Ephemeroptera larvae were even frequent (11% volume, occurring in 27% of the stomachs examined. Remaining larvae were not important, nor were the few fishes and Hydracarina.

The importance of ants as food was shown not only by their percentage of volume and their large number of individuals (mean 2.4), but also by their occurrence (in 73% of stomachs examined). Table 19.

This result was verified by the material from the collection in 1967 (W. JUNK, July): Formicoidea 38%, Ephemeroptera larvae 11%, and Coleoptera 12%.

Ig. Barro Branco — 42, 1 empty. The food items were frequently reduced to small pieces. So the single ants were not easy to count and the percentage of those items which could not be determined clearly, was larger.

The food was composed for the most part of terrestrial animals. Formicoidea (52%), Isoptera (7%), Coleoptera (7%), and Diptera (9%) altogether made up 75%. This was also reflected by their abundance. Crustacea, Hydracarinae, and larvae of insects were ingested incidentally (Table 20).

The 4 specimens at hand from the year 1967 verified this result.

Pyrrhulina brevis ingested ants.

(16) *Copella nattereri* (STEINDACHNER, 1875)
138 specimens (12) — Lago Calado.

Sd. l. 14.3—33.2 mm. Differing from the data of GERY, 1963a, the dorsal fin was further to the rear (sn-D/D-C 1.5), however, not reaching the caudal fin, and also, the ventral fins do not reach the anal fin. (Depth 4.8—5.9, head 3.8—4.5 in sd. l.; eye 2.6—3.4, i. o. 2.6—3.0 in the head. Scales predors. 12, sc. longit. 23 (26 ?). Colouration was more like *Copella compta*, a wide, dark, longitudinal stripe in the lower third of the body reaches the caudal basis.)

Stomach contents: 18, none empty.

Identifying the small pieces of insects was not always easy. The variability of food items in individual stomachs was conspicuous.

The percentage of Formicoidea (11%) was notable in this not very large fish species. Ants occurred in 40% of the stomachs examined, as did some Coleoptera, Hymenopetra and Isoptera (altogether 13%). The main food were the Ephemeroptera (31%) and other larvae (Odonata, Trichoptera, Lepidoptera, Coleoptera, and Chironomidae; 12%). The relatively large percentage of detritus was certainly related to the large number of larvae (contents of their guts) Table 21.

Copella nattereri ingested Ephemeroptera larvae and a remarkable percentage of Formicoidea.

d. Anostomidae

8. Anostominae

(17) *Leporinus friderici* (BLOCH, 1794)
15 specimens (13) — Lago Calado.

Sd. l. 192—267 mm. Depth 3.0—3.8, head 3.7—4.2 in sd. l.; i. o. 1.9—2.1 in the head. Dorsal fin somewhat behind the middle of the body. Scales lat. 36—39, sc. transv. 4.5/1/4.5. Colouration: only 3, sometimes 4, faint spots on the flank. The remaining biometric data were in good accordance with the specimens, given by GERY, 1960b, c, STEINDACHNER, 1875, and particularly by BÖHLKE, 1958: 96.

Stomach contents: 13, 2 empty.

The stomachs very often had rotted, so that the total intestines had to be examined. Assessment of the volume was not always possible. The scales, possibly remains of carrion, were mostly bundled together with plant matter.

Two types of food components were predominant: plant matter (31%) and coarse litter (16%), and fishes (30%) and Crustacea (16%). The latter consisted of scales and rare, but large, decapods (Palaemonidae ?). Sand and fruits were only accidental food; in contrast, plant remains were found in 61% and fishes in 46% of the stomachs examined (Table 22).

Leporinus friderici ingested plant matter and scales, as well as some decapods (Crustacea).

e. Curimatidae

9. Chilodinae

(18) *Chilodus punctatus* MÜLLER & TROSCHEL, 1844
3 specimens (3) — Lago Calado.

Sd. l. 48.8—59.3 mm. Depth 3.4—3.6, head 3.3—3.5 in sd. l.; i. o. 2.9—3.1 in the head. D iii 9, A iii 10 (i). Scales predors. 5—6, sc. lat. 26—27. Gill rakers about 20. Peduncle rather longer than high. Colouration: a dark stripe, reaching from the tip of snout (a little below the lateral line) to the basis of caudal, the middle caudal rays were dark.

Possibly these specimens were identical with that species from the Rio Japuru (Upper Solimões) reported by GERY, 1964a: 66, till now, only known from a photo by H. SCHULTZ.

Stomach contents: 3, none empty.

The stomach contents were very similar. For the most part, detritus mixed with many grains of sand, among which were chironomid larvae and ephemeropteran larvae.

10. Curimatinae

(19) *Curimatus spilurus* (?) GÜNTHER, 1864
8 specimens (5) — Lago Calado.

Sd. l. 26.0—42.3 mm. The present fishes were certainly a species of *Curimatus*. Probably they were juvenile forms of *C. spilurus*. Their depth was low (4.15 in sd. l.), as well as the number of scales in a longitudinal row (less than 30), among them only 6—8 perforated (MYERS, 1929, GERY, 1964b).

Stomach contents: 6, none empty.

There was sand (40%) and detritus (54%) in all stomachs. In one stomach there was plant matter.

(20) *Curimatus latior* (SPIX, in AGASSIZ, 1829)
1 specimen — Lago Calado.

Sd. l. 151 mm. Scales lat. 93. A ii 14.

Stomach contents: 1, not empty.

The food consisted of gray-black, very fine sand, and some larger grains.

11. Prochilodinae

(21) *Prochilodus theraponura* FOWLER, 1906
1 specimen — Lago Calado.

Sd. l. 93 mm. Depth 3.3 in sd. l.; eye and snout 3.0, i. o. 2.1 in the head. D iii 10, A iii 9. Scales predors. 12, sc. transv. 10/1/9.5, sc. lat. 48. Colouration: caudal fin with 7—8 longitudinal stripes.

Stomach contents: 1, not empty.

The contents consisted of very fine sand, detritus, and a large percentage of diatoms (10%).

f. Crenuchidae

(22) *Crenuchus spilurus* GÜNTHER, 1863
137 specimens (12) — Lago Calado.

Sd. l. 17.8—41.7 mm. This species is remarkable for its paired frontal foramina (GERY, 1963a).

Stomach contents: 25, 3 empty.

Mixed with detritus there were single larvae or Crustacea, scarcely recognizable.

More than half (55%) of the volume was filled by detritus which perhaps was picked up along with the larvae of Ephemeroptera (15%) and the Crustacea (Ostracoda, Copepoda), 10%. In addition, 10% was chitinous remains (Table 23).

Crenuchus spilurus ingested detritus, Ephemeroptera larvae and Crustacea.

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea	0.36	1.8		1	6
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		7.3		1	6
coarse litter		51.4		5	31
plant matter		12.7		4	25
chitinous remains					
detritus		10.5		5	31
aquat. Coleoptera					
Hemipteroidea					
larvae: Ephemeroptera					
larvae: Odonata					
larvae: Trichoptera					
larvae: Lepidoptera					
larvae: Coleoptera					
larvae: Diptera					
sand		7.2		3	19
algae.					
Hydracarina					
Crustacea					
fishes	0.54	9.1		1	6
		100.0			124

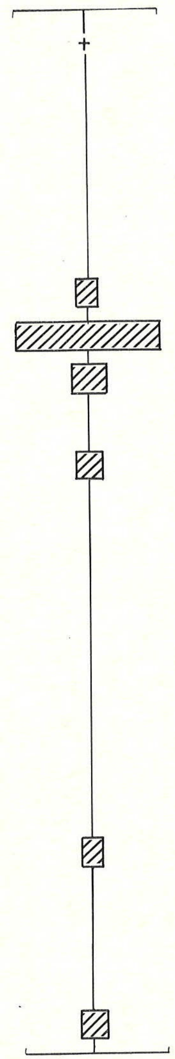

Table 6 Brycon melanopterus

Lago Calado, 16 indiv., 194–226 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea	3.42	32.9		17	95
Hymenoptera	0.59	8.0		6	33
Isoptera	1.26	12.7		12	60
terr. Coleoptera	0.17	4.3		3	16
Diptera	0.24	3.2		4	22
Arachnea	0.35	1.5		3	16
fruits		6.8		4	22
coarse litter					
plant matter		5.3		4	22
chitinous remains		8.0		6	33
detritus					
aquat. Coleoptera					
Hemipteroidea	0.47	8.0		6	33
larvae					
Ephemeroptera	0.59	4.7		4	22
Odonata					
Trichoptera					
Lepidoptera	0.11	2.0		2	11
Coleoptera					
Diptera					
sand					
algae					
Hydracarina					
Crustacea					
fishes		2.6		5	28
		100.0			413

Table 7 Bryconops inpai

Barro branco (1965) ; 18 indiv. ; 54.8–93.0 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea	2.88	43.6		28	88
Hymenoptera	0.09	2.5		3	9
Isoptera	1.32	8.5		7	22
terr. Coleoptera	0.15	3.7		5	16
Diptera	0.15	4.9		8	25
Arachnea	0.09	0.8		3	9
fruits		5.5		8	25
coarse litter					
plant matter		1.5		3	9
chitinous remains		4.7		6	19
detritus					
aquat. Coleoptera	0.02	2.2		2	6
Hemipteroidea	0.15	5.7		7	22
larvae					
Ephemeroptera	0.15	7.4		10	31
Odonata					
Trichoptera	0.17	3.0		5	16
Lepidoptera	0.06	3.1		2	6
Coleoptera					
Diptera					
sand					
algae					
Hydracarina					
Crustacea					
fishes		2.9		2	6
		100.0			308

Table 8 Bryconops inpai

Barro branco (1967) ; 32 indiv. ; 42.0 –98.0 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea	0.39	22.9		13	33
Hymenoptera					
Isoptera					
terr. Coleoptera	0.14	4.8		3	8
Diptera					
Arachnea					
fruits		6.9		5	13
coarse litter		3.6		4	10
plant matter		14.0		9	23
chitinous remains		4.0		3	8
detritus		11.8		7	18
aquat. Coleoptera	0.21	6.1		5	13
Hemipteroidea	0.35	4.8		5	13
larvae					
Ephemeroptera	0.25	10.8		6	15
Odonata	0.03	1.6		1	3
Trichoptera					
Lepidoptera					
Coleoptera	0.07	1.4		2	5
Diptera					
sand		2.8		4	10
algae		0.3		1	3
Hydracarina	0.07	0.7		2	5
Crustacea	0.57	3.4		5	13
fishes					
		100.0			193

Table 9 Hemigrammus ocellifer

Lago Calado, 39 indiv., 17.6 – 38.2 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea		31.6		8	58
Hymenoptera					
Isoptera		4.3		1	7
terr. Coleoptera					
Diptera					
Arachnea		10.6		2	15
fruits					
coarse litter					
plant matter					
chitinous remains		21.9		7	50
detritus					
aquat. Coleoptera					
Hemipteroidea					
larvae					
Ephemeroptera		29.1		7	50
Odonata					
Trichoptera		1.1		1	7
Lepidoptera					
Coleoptera					
Diptera		1.4		1	7
sand					
algae					
Hydracarina					
Crustacea					
fishes					
		100.0			194

Table 10 Hyphessobrycon bellotti

Barro branco, 14 indiv., 25.4 – 34.1 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea	0.20	7.8		5	15
Hymenoptera	0.17	6.3		5	15
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea	0.07	0.4	+	2	6
fruits					
coarse litter					
plant matter		17.8		12	36
chitinous remains		11.7		7	21
detritus		19.0		10	30
aquat. Coleoptera	0.13	5.7		3	9
Hemipteroidea	0.63	8.1		5	15
larvae: Ephemeroptera	0.43	10.5		8	24
larvae: Odonata					
larvae: Trichoptera	0.13	9.0		3	9
larvae: Lepidoptera	0.03	2.5	+	1	3
larvae: Coleoptera					
larvae: Diptera	0.13	0.5	+	1	3
sand					
algae					
Hydracarina					
Crustacea	0.03	0.7	+	1	3
fishes					
		100.0			189

Table 11

Hyphessobrycon bellotti

Lago Calado, 34 indiv., 17.2 – 37.5 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera		5.6	+	1	6
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		3.9	+	1	6
coarse litter		13.9		4	23
plant matter		18.9		8	45
chitinous remains		5.6		4	23
detritus		40.0		13	73
aquat. Coleoptera					
Hemipteroidea		5.6		1	6
larvae: Ephemeroptera		3.3	+	1	6
larvae: Odonata					
larvae: Trichoptera					
larvae: Lepidoptera					
larvae: Coleoptera					
larvae: Diptera					
sand		1.1	+	3	17
algae		2.2	+	2	11
Hydracarina					
Crustacea					
fishes					
		100.0			216

Table 12

Moenkhausia ceros

Lago Calado, 18 indiv., 30.0 – 36.8 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea		1.3		1	6
Hymenoptera		2.0		1	6
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		6.6		1	6
coarse litter					
plant matter		19.0		12	80
chitinous remains		4.0		1	6
detritus		39.7		9	60
aquat. Coleoptera		4.0		1	6
Hemipteroidea	0:33	6.0		1	6
larvae					
Ephemeroptera		6.7		1	6
Odonata					
Trichoptera					
Lepidoptera					
Coleoptera		2.0		1	6
Diptera					
sand		4.7		5	33
algae		4.0		1	6
Hydracarina					
Crustacea					
fishes					
		100.0			240

Table 13 Moenkhausia lepidura

Lago Calado, 15 indiv., 33.4 – 58.4 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter		4.0		1	9
plant matter		6.0		2	18
chitinous remains		16.0		4	36
detritus		55.0		8	73
aquat. Coleoptera		10.0		1	9
Hemipteroidea					
larvae					
Ephemeroptera		2.0		1	9
Odonata					
Trichoptera					
Lepidoptera					
Coleoptera					
Diptera		3.0		4	36
sand					
algae					
Hydracarina					
Crustacea		4.0		1	9
fishes					
		100.0			172

Table 14 Megalamphodus micropterus

Lago Calado, 11 indiv., 21.0 – 30.4 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter		31.7		2	22
plant matter		18.3		3	33
chitinous remains					
detritus					
aquat. Coleoptera					
Hemipteroidea					
larvae					
Ephemeroptera					
Odonata					
Trichoptera					
Lepidoptera					
Coleoptera					
Diptera					
sand		20.0		3	33
algae					
Hydracarina					
Crustacea					
fishes	0.5	30.0		2	22
		100.0			110

Table 15 Hoplias malabaricus

Lago Calado, 9 indiv., 59.9–153.2 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		7.0		2	10
chitinous remains					
detritus					
aquat. Coleoptera		9.3		2	10
Hemipteroidea					
larvae					
Ephemeroptera	3.51	38.4		7	35
Odonata					
Trichoptera	0.30	20.3		4	20
Lepidoptera		10.7		2	10
Coleoptera		1.3	+	2	10
Diptera					
sand					
algae					
Hydracarina					
Crustacea					
fishes		13.0		2	10
		100.0			105

Table 16 Hoplerythrinus unitaeniatus

Tarumã, 21 indiv., 35.0–129.4 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		28.3		4	40
chitinous remains					
detritus					
aquat. Coleoptera		5.7		1	10
Hemipteroidea					
Ephemeroptera		18.5		4	40
Odonata					
larvae Trichoptera					
Lepidoptera					
Coleoptera					
Diptera					
sand					
algae					
Hydracarina					
Crustacea		45.0		5	50
fishes		2.5	+	1	10
		100.0			170

Table 17

Hoplerythrinus unitaeniatus

Barro branco, 10 indiv., 46 – 136 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		36.3		12	75
chitinous remains		1.2	+	1	6
detritus		50.3		14	88
aquat. Coleoptera					
Hemipteroidea					
Ephemeroptera					
Odonata					
larvae Trichoptera					
Lepidoptera					
Coleoptera					
Diptera					
sand		2.5		6	38
algae		9.7		5	31
Hydracarina					
Crustacea					
fishes					
		100.0			238

Table 18

Poecilobrycon unifasciatus

Lago Calado, 16 indiv., 27.8 – 33.0 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	2.40	56.7		80	73
Hymenoptera	0.03	2.4		3	3
Isoptera	0.06	0.8		4	4
terr. Coleoptera	0.10	4.5		9	8
Diptera	0.12	3.9		12	11
Arachnea	0.02	0.2		2	2
fruits					
coarse litter					
plant matter		3.2		10	9
chitinous remains		2.4		3	3
detritus		2.5		5	5
aquat. Coleoptera	0.06	1.9		4	4
Hemipteroidea	0.06	2.8		7	6
larvae					
Ephemeroptera	0.08	11.2		29	27
Odonata					
Trichoptera		2.0		5	5
Lepidoptera	0.01	0.5		1	1
Coleoptera	0.04	0.8		3	3
Diptera	0.02	2.0		2	2
sand					
algae					
Hydracarina	0.06	0.5		5	5
Crustacea					
fishes	0.14	1.6		2	2
		100.0			179

Table 19 Pyrrhulina brevis

Tarumã, 110 indiv., 20 – 74 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	3.65	52.0		37	83
Hymenoptera	0.09	1.6		4	10
Isoptera	0.71	6.4		10	24
terr. Coleoptera	0.17	7.1		8	19
Diptera	0.34	8.6		11	26
Arachnea		0.2		1	2
fruits	0.17	2.9		2	5
coarse litter					
plant matter		7.8		7	17
chitinous remains		5.2		8	19
detritus					
aquat. Coleoptera		1.9		2	5
Hemipteroidea	0.17	3.0		4	10
larvae					
Ephemeroptera		1.0		2	5
Odonata					
Trichoptera	0.09	1.3		4	10
Lepidoptera					
Coleoptera					
Diptera					
sand					
algae.					
Hydracarina	0.32	0.6		3	8
Crustacea		0.5		1	2
fishes					
		100.0			268

Table 20 Pyrrhulina brevis

Barro branco, 42 indiv., 22.0 – 71.1 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	0.44	10.4		7	39
Hymenoptera	0.17	8.9		3	17
Isoptera	0.22	2.5		2	11
terr. Coleoptera	0.17	1.4		2	11
Diptera					
Arachnea					
fruits		1.1		1	5
coarse litter					
plant matter		1.9		2	11
chitinous remains					
detritus		19.7		6	33
aquat. Coleoptera					
Hemipteroidea		0.8		1	5
larvae					
Ephemeroptera	2.44	31.1		10	55
Odonata	0.17	3.3		1	5
Trichoptera	0.11	3.1		2	11
Lepidoptera		2.0		1	5
Coleoptera	0.17	3.3		2	11
Diptera	0.17	0.6		1	5
sand					
algae		9.7		4	22
Hydracarina					
Crustacea					
fishes					
		100.0			246

Table 21 Copella nattereri

Lago Calado, 18 indiv., 14.3–33.2 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		1.3		1	8
coarse litter		16.4		4	31
plant matter		31.4		8	62
chitinous remains					
detritus					
aquat. Coleoptera					
Hemipteroidea					
larvae					
Ephemeroptera					
Odonata					
Trichoptera					
Lepidoptera					
Coleoptera					
Diptera					
sand		4.1		3	23
algae					
Hydracarina					
Crustacea		15.9		3	23
fishes		30.9		6	46
		100.0			193

Table 22 Leporinus friderici

Lago Calado, 13 indiv., 192–267 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		4.5	+	1	4
chitinous remains		10.4		4	16
detritus		55.6		17	68
aquat. Coleoptera					
Hemipteroidea					
larvae: Ephemeroptera	0.45	15.5		5	20
larvae: Odonata					
larvae: Trichoptera	0.09	2.7	+	2	8
larvae: Lepidoptera					
larvae: Coleoptera					
larvae: Diptera					
sand					
algae					
Hydracarina	0.18	0.6	+	2	8
Crustacea	0.18	10.7		4	16
fishes					
		100.0			140

Table 23

Crenuchus spilurus

Lago Calado, 25 indiv., 17.8 - 41.2 mm

2. GYMNOTOIDEI

a. Gymnotidae

(23) *Gymnotus carapo* LINNAEUS, 1758
Carapó, Pirá mboi; 2 specimens (2) — Ig. Barro branco, 4 specimens (4) — Lago Calado.

Sd. l. 249—386 mm (total). Depth 8.6—10.3, head 7.6—8.3 in total length. The present fishes agreed completely with the usual descriptions of *G. carapo* (ELLIS, 1913, GERY & VU-TAN-TUE 1964, NIJSSEN & ISBRÜCKER, 1968).

Stomach contents: 6, none empty.

At both localities aquatic animals were eaten. One stomach each was filled with fishes, Crustacea (decapods) or insect larvae (Odonata, Trichoptera, and Coleoptera). Also, a large percentage of plant matter was to be noted, which may be ingested along with the larvae.

(24) *Gymnotus anguillaris* HOEDEMANN, 1962
184 specimens (35) — Ig. Tarumã, 43 specimens (30) — Ig. Barro branco.

Sd. l. 36—254 mm (total). Depth 10.3—14.9, head 9.2—11.7 in the total length. (The specimens from the Ig. Barro branco were somewhat lower in the depth). The fishes were in very good accordance with the description and the photo of their habitus and, especially, their colouration, given by NIJSSEN & ISBRÜCKER, 1968: 162. Also the length of the head (about 9.5 in the total length, *G. carapo* about 7.6—8.3), as well as the *anguillaris* - colouration and the cylindrical, eel - like body were in accordance with the cited authors.

A number of specimens, however, were striped all the way up to the head. If the length of fishes was less than 100 mm, a clear distinction from *G. carapo* was difficult.

It remains to be seen, whether additional findings of *G. anguillaris* from the Amazon and other South-American regions, in future will allow the two species to be differentiated more carefully.

Here the occurrence of *Gymnotus anguillaris* in the Rio Negro region is reported for the first time.

Stomach contents:

Ig. Tarumã — 114, 5 empty. The larvae of insects were broken up into very small pieces and their percentages were hard to estimate.

Trichoptera (37%) and Ephemeroptera larvae (23%) were clear the favoured food items. They occurred in 58% and 40% of the stomachs examined. Also chironomids (Diptera larvae, 10%) were eaten very frequently (in 32% of the stomachs examined).

Besides, there were occasionally to be found: ants, some Lepidoptera, Odonata, Coleoptera larvae, and Crustacea (decapods) Table 24.

This result again has been verified by examining 34 fishes from the year 1967 (leg. W. JUNK): Trichoptera, 43%, Ephemeroptera and Diptera larvae, 8% (Table 25).

Ig. Barro branco — 33, 4 empty. Similar to the specimens from the Ig. Tarumã, the contents were broken up into small pieces and the percentages barely estimable.

Again the percentage of Trichoptera larvae (30%) was highest. Ephemeroptera and Diptera larvae (each 12%) were present in large quantities. In addition, there were again, possibly accidentally, Formicoidea, Coleoptera, Lepidoptera larvae, Crustacea, and fish remains. Among the plant matter (9%) some pieces of moss were counted (Table 26).

Gymnotus anguillaris at both localities, Ig. Tarumã and Ig. Barro branco, ingested insect larvae, for the most part Trichoptera, and a smaller number of Ephemeroptera and Diptera.

b. Rhamphichthyidae

1. Sternopyginae

(25) *Sternopygus macrurus* (BLOCH & SCHNEIDER, 1801)
7 specimens (4) — Ig. Barro branco.

Sd. l. 70—240 mm (total). These specimens were in accordance with the data in ELLIS, 1913.

Stomach contents: 7, none empty.

Nearly always there were various food items in the stomach. The larvae of insects were well recognizable among the larger quantities of chitinous remains.

Among the high percentage of insect larvae, the number of Trichoptera (40%) and Ephemeroptera (10%) were especially evident. In addition, detritus and a shield-louse, as well as plant matter, were notable. A big, indeterminable chitinous fraction remained (18%).

It was to be noted that, in each stomach examined, Trichoptera larvae were found.

(26) *Eigenmannia macrops* (BOULENGER, 1897)
2 specimens (2) — Lago Calado.

Sd. l.: one specimen 85 mm total; one specimen without tail, length of the body to the end of anal fin 72 and 93 mm. A 170 and 194. Depth 6.2—6.5, head 8.0 and 8.3 in the length of the body to the end of the anal fin; eye larger than maxillary. Colouration: the whole body yellowish-brownish, only the basis of the anal fin and the lateral line were coloured darkly. A narrow brown line on the back line. The head slightly dark.

Stomach contents: 1, not empty.

There were only chitinous remains of Trichoptera and a fraction of Chironomidae larvae.

(27) *Steatogenes elegans* (?) STEINDACHNER, 1880
Corybu; 4 specimens (4) — Ig. Brarro branco, 9 specimens — Lago Calado.

Sd. l. 38.1—88.9 mm (total). Depth 5.5—7.5, head 6.6—7.5 in the length of the body to the end of anal fin. Long, thin tail, more than a third of the total length. A 136, 165, 167. No teeth. Colouration: the brownish, yellow body is crossed by many dark-brown, irregularly set bars which are divided below the middle line to irregular spots.

As some meristic data do not agree with those of earlier descriptions of *S. elegans* and as the two little filaments in the mental region cannot be found, the taxonomic placement must be dubious.

Stomach contents:

Ig. Barro branco — 4, none empty. The parts of larvae were well identifiable. Sometimes they were reduced to small pieces. Trichoptera and Diptera larvae filled the stomach equally. One Ephemeroptera was found.

Lago Calado — 7, none empty. Digestion had proceeded to different stages. The high percentage of detritus consisted for the most part of the abdomens of dipteran larvae.

More than half of the stomachs (52%) was filled by Diptera larvae, followed by detritus (25%). Some Copepoda (Crustacea 9%) and some Ephemeroptera larvae (5%) were also found.

2. Rhamphichtyinae

(28) *Gymnorhamphichthys hypostomus* (ELLIS, 1913) cf. *ssp. nov.*
9 specimens (9) — Ig. Barro Branco.

Sd. l. 220—271 mm (total). These specimens differed in several data from the original description of the species ELLIS, 1913 and the subspecies *G. hypostomus petiti* GERY & VU-TAN-TUE, 1964. An exact description of the present subspecies may follow in a special paper.

Stomach contents: 8, none empty.

The stomachs were packed full of a large number of green chironomid larvae and with small pieces of Trichoptera larvae.

The food consisted for the most part of chironomids (Diptera larvae 43%) and Trichoptera larvae (38%) in which the number of Diptera was nearly 3 times the number of Trichoptera larvae. Both items were found in all stomachs. The Elminthidae (Coleoptera larvae 6%) and a Curculionidae (Coleoptera) may have been picked up accidentally, as may some Ephemeroptera larvae (6%).

3. SILURIFORMES

a. Helogeneidae

(29) *Helogenes amazonae* DELSMAN, 1941
6 specimens (6) — Ig. Barro branco.

Sd. l. 40.6—70.3 mm. Depth 4.1—4.6, head 4.9—5.4 in sd. l. D 5—6, dorsal fin significantly nearer to the caudal than to the head (sn-D 1.6 in the sd. l.). Pectoral length equal to the head (or slightly longer), V 6, A 41—43. The colouration was exactly as in the original description of DELSMAN, 1941. The meristic data and the number of anal rays of these specimens were between those data, given by EIGENMANN, 1912, for *H. marmoratus* and by DELSMAN, 1941 for *H. amazonae*. So it is possible that all specimens described up to now, must brought together in one species. If one takes in consideration, however, the figure in EIGENMANN, 1912 (Table xxii, fig. 2), it seems to be correct, establishing the species *H. amazonae*. In addition, the locus typicus of *H. amazonae* was Manaus, whereas *H. marmoratus* has been reported so far only from the Guianas.

Stomach contents: 6, none empty.

In part, tightly stomachs filled, in which were to be found completely preserved ants of various sizes and some Coleoptera. On the other hand, there were stomachs containing only very small pieces. More than 9 ants were counted, as well as one beetle (Curculionidae) and two small species of other Coleoptera, and one shield louse.

Ants made up 80% of the mean stomach contents.

b. Callichthyidae

(30) *Callichthys callichthys* LINNAEUS, 1758
88 specimens (10) — Ig. Tarumã, 2 specimens — Barro branco.

Sd. l. 52.7—108.1 mm. Head 3.6—4.1, depth of the head 4.8—5.0 in sd. l. Number of scutes (upper series) 28—29; preadipose azygous plates 12—13, covering about half the distance to the last dorsal ray. D Ii 6, A I 6.

Stomach contents:

Ig. Tarumã — 50, 10 empty. The stomachs were only partially filled. Sometimes, when stomach contents were lacking, the contents of the intestine were determined. The great variability of food items was clearly distinguishable, because the insect larvae were preserved nearly whole.

The primary food component was Trichoptera larvae (31%) which partly were still in their cases. The Diptera larvae were certainly of more importance to the diet, judging from the high number of individuals (3.3) in contrast to only 0.3 Trichoptera. Also Diptera larvae (in 54% of stomachs examined) were more frequent than the Trichoptera. Besides, a large percentage of Ephemeroptera nymphs (14%) indicates their importance, and the number of Copepoda (Crustacea 9%) was noteworthy. The remains of aquatic beetles, cicadas, aquatic mites, and fishes present were picked up accidentally (each item occurred in one stomach only) Table 27.

23 stomachs examined from the year 1967 verified this result rather well, 36% Trichoptera; Ephemeroptera increased to 30%, but the Diptera larvae made up only 12% (Table 28).

Ig. Barro branco — 2, neither empty. Both stomachs filled with remains of insects in an advanced state of digestion. Only the parts of Trichoptera larvae were identifiable.

Callichthys callichthys ingested aquatic larvae, for the most part Trichoptera and Diptera.

c. Pimelodidae

(31) *Rhamdia sp.*
23 specimens (6) — Ig. Barro branco.

Sd. l. 55—275 mm. Maxillary barbels reaching the tip of pectorals, but, never reaching more than the middle of the adipose fin; adipose long (2.5—3.0 in sd. l.). The spine of pectoral fin serrated on both sides, in which the longer teeth were at the front side becoming more slender at the base

of the spine. D I 6, A 10—12, P I 9. Gill rakers 10—12. Depth 6.0—6,3, head 4.1—4.5, width of the head 1.2—1.3 in sd. l.; eye 5.9—6.0 in the head, and 2.0 in the interorbital width; i. o. 2.8—3.0 in the head. The distance from adipose to dorsal fin short (1—2 diameters of eye). Colouration: homogenuously gray-brownish body with light silvery belly. Above lateral line many irregular, small, dark spots which decrease ventrally. The head lacks spots.

The present specimens cannot be put in described species. The relatively short maxillary barbels, the interorbital and the length of the head, as well as the low number of gill rakers allow assumption of close relationship to *Rhamdia quelen.*

Stomach contents: 12, none empty.

The contents were often broken into very small pieces, and there was always a large fraction of scarcely identifiable vegetable and chitinous remains. The insect larvae were only determinable from their parts. Also the fish remains were accompanied by coarse litter or other items.

The percentages of not clearly determinable items were very high (23% chitinous remains, 9% detritus, and 17% coarse litter). The larvae of insects (23%) consisted predominantly of Trichoptera (15%) and some Diptera, Odonata, and Ephemeroptera. The percentage of fish eaten (15%) was important, remains of *Pyrrhulina*, cichlids, gymnotids. Besides single Crustacea (Decapoda, Palaemonidae?), some moss pieces, one beetle, one bug, even ants and termites (4%) were found (Table 29).

11 additional specimens from the year 1967 showed a similar result. Again, the variability of food eaten was great. The percentage of Formicoidea (11%) was notable. Otherwise, there was an important volume of Coleoptera (12%), Table 30.

Rhamdia sp. ingested insect larvae from near the bottom, but also fishes and ants.

d. Loricariidae

There were several species of 1—3 specimens each which possibly belonged to *Pseudancistrus*, *Ancistrus*, *Pterygoplichthys*, and *Loricaria.*

The stomach contents were similar to those of *Rhamdia sp.*

4. CYPRINODONTOIDEI

a. Cyprinodontidae

1. Fundulinae

(32) *Rivulus sp.* (*urophthalmus*-complex)
14 specimens (12) — Ig. Tarumã.

Sd. l. 27.8—53.8 mm. The present specimens belong to the *urophthalmus* — complex. They resemble *Rivulus stagnatus/lanceolatus* in several characteristics. Nevertheless, differences in some data did not allow these specimens to be put into the named species conclusively. In a special paper, the exact taxonomic order will be reported.

Stomach contents: 4, all empty.

5. PERCOIDEI

a. Nandidae

(33) *Monocirrhus polyacanthus* Heckel, 1840
Pirà-cara; 2 specimens — Lago Calado.

Sd. l. 37.2 and 62.3 mm.

Stomach contents: 2, neither empty.

Each filled with well-preserved fishes (*Hyphessobrycon bellotti*, 20 and 10 mm total length).

b. Cichlidae

(34) *Cichla ocellaris* Bloch & Schneider, 1801
Tucunaré Jacundá; 2 specimens — Lago Calado.

Sd. l. 257 and 281 mm.

Stomach contents: 2, neither empty.

The intestines very rotten. Nevertheless, there were well recognizable in one stomach: 8 fishes (one specimen about 80 mm, 7 specimens 20 mm). In the other stomach was one fish about 50 mm.

(35) *Chaetobranchus flavescens* Heckel, 1840
1 specimen — Lago Calado

Sd. l. 179.3 mm. The meristic data were nearly in agreement with those given by Eigenmann, 1912: 484. (Depth 2.4, head 2.5 in sd. l.; eye 4.2, i. o. 2.9 in the head. D XIII 13, A III 11. Scales on the operculum 4—6.)

Stomach contents: 1, rotten. No contents determinable.

(36) *Aequidens tetramerus* (Heckel, 1840)
Acará Pixuna; 191 specimens (8) — Ig. Tarumã, 151 specimens — Ig. Barro branco, 5 specimens — Lago Calado.

Sd. l. 16.0—146.3 mm. (sd. l. 87.5—146.3; depth 2.3—2.6, head 2.6—3.0 in sd. l.; eye 3.3—3.7, i. o. 2.9—3.3 in the head. Length of peduncle to its depth 0.9. D XV 11 or XIV 12, A III 9. Scales longit. 27—28, sc. transv. 3/1.5—2.5, sc. on operculum 2—4. Gill rakers 6—8).

The specimens from the other localities (Barro branco, Lago Calado) were not different from those named above.

Ae. tetramerus was distinguished by great variety. At first, 1958, a particular description of the type-specimen *Aequidens tetramerus* Eigenmann & Bray, 1894, was given by H. Travassos & S. Y. Pinto. This was done in order to be generally capable of making comprehensible the validity and synonymity of the extant descriptions.

Stomach contents:

The contents (stomach and intestine) differed very much. Mostly, Ephemeroptera remains were conspicuous by the long cerci of their abdomens. The chironomids gave the impression that they originated from abdomens of the Ephemeroptera larvae. The unidentifiable parts were of vegetable origin and it may be that they were picked up along with the larvae.

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea		0.1	+	1	1
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera		0.2	+	1	1
Arachnea					
fruits					
coarse litter					
plant matter		4.2	+	10	8
chitinous remains		1.0	+	2	2
detritus		2.5	+	6	5
aquat. Coleoptera		2.5	+	4	4
Hemipteroidea					
larvae: Ephemeroptera	0.76	24.6		48	42
larvae: Odonata	0.03	2.2	+	4	4
larvae: Trichoptera	1.12	36.7		67	59
larvae: Lepidoptera		2.2	+	4	4
larvae: Coleoptera		2.8	+	4	4
larvae: Diptera	1.70	9.8		38	32
sand		2.6	+	3	3
algae					
Hydracarina					
Crustacea	0.10	8.6	+	11	10
fishes					
		100.0			183

Table 24 Gymnotus anguillaris

Tarumã, 114 indiv., 47 - 195 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		9.3		5	15
chitinous remains					
detritus		1.9		2	6
aquat. Coleoptera					
Hemipteroidea					
larvae					
Ephemeroptera	1.38	27.8		18	53
Odonata	0.10	6.1		3	9
Trichoptera	1.55	42.5		24	70
Lepidoptera					
Coleoptera	0.06	1.0		2	6
Diptera	1.86	8.4		13	38
sand					
algae					
Hydracarina	0.03	0.1		1	3
Crustacea	0.06	2.9		2	6
fishes					
		100.0			206

Table 25

Gymnotus anguillaris

Tarumã (1967), 34 indiv., 36.0–194.0 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera	0.34	2.1		2	6
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		8.9		8	24
chitinous remains		7.2		6	18
detritus					
aquat. Coleoptera	0.25	5.3		5	15
Hemipteroidea					
larvae					
Ephemeroptera	0.51	12.4		12	42
Odonata	0.34	12.0		8	24
Trichoptera	6.55	29.5		22	66
Lepidoptera	0.17	3.8		5	15
Coleoptera	0.07	3.4		3	9
Diptera	1.76	12.0		16	48
sand					
algae					
Hydracarina					
Crustacea		2.7		2	6
fishes		0.4		1	3
		100.0			288

Table 26

Gymnotus anguillaris

Barro branco, 33 indiv., 73 – 245 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		2.2		1	2
coarse litter					
plant matter		11.2		11	22
chitinous remains					
detritus		3.4		5	10
aquat. Coleoptera		0.5		1	2
Hemipteroidea		0.9		1	2
larvae					
Ephemeroptera	0.30	14.1		13	26
Odonata					
Trichoptera	0.30	31.3		23	46
Lepidoptera					
Coleoptera		2.5		1	2
Diptera	3.30	24.0		27	54
sand					
algae					
Hydracarina		0.2		1	2
Crustacea		8.5		6	12
fishes		1.2		1	2
		100.0			188

Table 27 *Callichthys callichthys*

Tarumã, 50 indiv., 52.7 – 108.1 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		3.6		3	13
chitinous remains		5.5		1	4
detritus		5.1		3	13
aquat. Coleoptera	0.05	3.0		1	4
Hemipteroidea					
larvae					
Ephemeroptera	1.33	30.0		15	65
Odonata					
Trichoptera	1.78	36.4		15	65
Lepidoptera					
Coleoptera	0.05	1.1		1	4
Diptera	3.16	12.0		10	43
sand					
algae					
Hydracarina	0.05	0.2		1	4
Crustacea	0.39	3.1		1	4
fishes					
		100.0			219

Table 28 *Callichthys callichthys*

Tarumã (1967), 23 indiv., 41.3 – 99.2 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea		3.3	+	3	25
Hymenoptera					
Isoptera		0.4	+	1	8
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter		17.1		4	33
plant matter		2.8	+	1	8
chitinous remains		23.3		6	51
detritus		8.8		2	17
aquat. Coleoptera		2.5	+	2	17
Hemipteroidea		2.9	+	2	17
larvae					
Ephemeroptera		0.8	+	1	8
Odonata		4.2	+	2	17
Trichoptera		14.6		6	50
Lepidoptera					
Coleoptera					
Diptera		3.3	+	1	8
sand					
algae					
Hydracarina					
Crustacea		1.0	+	1	8
fishes		15.0		4	33
		100.0			300

Table 29

Rhamdia sp.

Barro branco (1965), 12 indiv., 97 – 275 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea		11.4		4	36
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		1.4	+	1	9
chitinous remains		11.8		2	18
detritus		17.3		5	45
aquat. Coleoptera		11.8		4	36
Hemipteroidea					
larvae					
Ephemeroptera		16.4		7	63
Odonata		13.6		5	45
Trichoptera		8.6		5	45
Lepidoptera					
Coleoptera					
Diptera		0.9	+	1	9
sand					
algae					
Hydracarina		0.5	+	1	9
Crustacea		3.6	+	1	9
fishes		2.7	+	1	9
		100.0			333

Table 30

Rhamdia sp.

Barro branco (1967), 11 indiv., 55 – 176 mm

Ig. Tarumã — 77, none empty. At once the variability of food items was conspicuous, an even percentage of volumes with no dominants. Ephemeroptera (19%), Trichoptera (18%), and Diptera larvae (10%) made up important percentages, both in volume and numbers of individuals: Ephemeroptera 2.6, Trichoptera 1.5, and Diptera 3.6. The importance of these larvae for the diet was also reflected in their occurrences. All named larvae were to be found in more than half of the stomachs examined.

Besides, plant matter (15%), which was composed of stems, leafy remains and some filamentous algae, was important; a few fruits were noted.

The fractions of ants (Formicoidea 8%) and Coleoptera (2%) were noteworthy. These items were to be found in 22% of the stomachs examined. On the other hand, some scales and remains of fishes (5%) were to be found, as well as a few Crustacea (8%), Table 31.

73 fishes examined from the year 1967 verified this result exactly: Ephemeroptera (22%), Trichoptera (25%), and chironomids (Diptera larvae 12%) were predominant; plant matter (13%) and ants (5%), Table 32.

Ig. Barro branco — 19, none empty. The stomach contents were similar to those forms from the Ig. Tarumã. The aquatic larvae of insects (54%) were composed of: Ephemeroptera (18%), Trichoptera (24%), and Diptera (10%). A few Odonata, Lepidoptera, and Coleoptera larvae were found. Notable amounts of plant matter (10%), Formicoidea (4%) and fishes (6%) were also eaten (Table 33).

18 other specimens from the year 1967 verified this result fairly well.

Lago Calado — 5,2 empty. The contents were preserved well. In particular, ants (4 individuals) and one beetle (Curculionidae) were conspicuous. Still, the remains of Ephemeroptera larvae made up the largest percentage.

Aequidens tetramerus ingested aquatic larvae of insects (Ephemeroptera, Trichoptera, Chironomidae); the vegetable percentages were accordingly large. Ants and fishes occurred.

(37) *Acaronia nassa* (Heckel, 1840)
Cará, Boca de Inquia; 158 specimens (29) — Lago Calado.

Sd. l. 23.0—137.5 mm. Depth 2.2—2.6, head 2.1—2.6 in sd. l; eye 2.4—3.7, i. o. 3.2—4.1, snout 2.1—2.3 in the head. D XIII 9, A III 8—9. Scales lat. 15—17 and 6—9, sc. longit. 23—24. Gill rakers 8—10. Depth was somewhat lower than described by Regan, 1905a, and Eigenmann, 1912.

Stomach contents: 31, 3 empty.

In the stomachs there was nearly always a notable percentage of detritus and plant matter.

More than half of the volume was filled with detritus (31%) and plant matter (21%). In addition, there was a large percentage of Ephemeroptera (20%), which occurred in only 25% of the stomachs examined, but detritus and plant matter occurred in about 50%. Otherwise, there were Crustacea (7%), Ostracoda, Copepoda, Decapoda, as well as some bugs and beetles (Table 34).

Acaronia nassa ingested detritus and plant matter along with Ephemeroptera larvae.

(38) *Acarichthys heckelii* (Müller & Troschel, 1848)

11 specimens (4) — Lago Calado.

Sd. l. 30.8—100.6 mm. In the meristic data, the rays and scales were in good accordance with the data given by Eigenmann, 1912: 500.

Stomach contents: 11, none empty.

The contents were very clearly formed by the plant matter (60%) and fruits (27%). But the rest was filled by scales (10%), Hydracarina and Crustacea (Copepoda, ephippia 2%) Table 35.

Acarichthys heckelii ingested plant matter.

(39) *Geophagus jurupari* Heckel, 1840
Jupari pinda; 64 specimens (16) — Lago Calado.

Sd. l. 19.9—136 mm. The meristics and the colouration were in accordance with the known descriptions (e. g. Regan, 1906).

Stomach contents: 28, 1 empty.

The food items could mostly be counted, because many of the seeds (fruits), Crustacea, Hydracarina and larvae were preserved. Nevertheless, the stomach contents were mostly a mixture ot these items with detritus and plant matter. The individual percentages of fruits, plant matter, Crustacea (Copepoda, Ostracoda, ephippia, each one third) and detritus were nearly equal, that is about 20%. In addition, a fish and an aquatic Coleoptera had been eaten (Table 36).

Geophagus jurupari ingested seeds (fruits) and plant matter, as well as Crustacea.

(40) *Apistogramma agassizii* (Steindachner, 1875)
16 specimens (13) — Lago Calado.

Sd. l. 18.0—31.1 mm. Depth 3.0—3.3, head 2.8—3.0 in sd. l.; eye 2.7—3.3, i. o. 3.5—4.0 in the head. D XIV—XV 6—7, A III 5—6. Scales lat. 12—14 and 5—7, sc. longit. 23—25. Colouration was in accordance with usual descriptions.

Stomach contents: 12, none empty.

The easily countable larvae and Hydracarina were always accompanied by larger percentage of detritus and plant matter. The large number of Hydracarina (9.8 individuals) was notable, making up 13% of the volume as well. But again, plant matter (22%) and detritus (27%), as well as fruits (10%) made up the largest percentages of volume. However, a series of insect larvae were also observed: Lepidoptera 4%, Coleoptera 5%, and Diptera 3%. Copepoda (Crustacea 3%) were also present. In nearly all stomachs, Hydracarina were found; the other items were found in half of the stomachs (Table 37).

Apistogramma agassizii ingested plant matter and detritus, as well as, peculiarly, many Hydracarina.

(41) *Crenicichla johanna* Heckel, 1840
Johanna guensa; 2 specimens — Ig. Barro branco, 11 specimens — Lago Calado.

Sd. l. 112—234 mm. Depth 4.5—(6.1), head 2.7—3.3 in sd. l.; eye 5.1—6.4, i. o. 3.5—4.4, snout (2.6)—3.3 in the head. D XXI—XXII 15—18, A III 11—12. Scales lat. 24—25 and 15—16, sc. longit. 96—109. Pmx. teeth in 4—5 rows; dn. teeth in 3 rows. Colouration: homogenuously brown, at the back 10—11 vertical dark stripes reaching the upper lateral line. These stripes covered the

dorsal line from occiput to the caudal fin, caudal without spots. There was always a light subimarginal band at the upper caudal lobe (at the lower lobe such a light band only sometimes existed). At the head a dark stripe reaches from the tip of snout to the outermost margin of the operculum (or beyond).

Stomach contents:

Ig. Barro brancô — 2, neither empty. The stomachs were well-preserved; the contents distinct, and consisted of: one decapod, one fish (characid which had eaten ants), some Ephemeroptera larvae, and plant matter.

Lago Calado — 6, 1 empty. (In five other specimens before investigating the intestines were unfortunately removed).

The intestines were all rotted; however, the stomachs were probably only moderately full.

In more than 50% of the stomachs examined, fish remains (*Hyphessobrycon bellotti* ?) were found, which made up 42% of the volume. A large percentage of plant matter (25%) in 65% of the stomachs examined, as well as Ephemeroptera larvae and bugs in one stomach each completed the food.

Crenicichla johanna ingested fishes and larger percentages of plant matter.

(42) *Crenicichla lugubris* HECKEL, 1840
24 specimens (9) — Lago Calado.

Sd. l. 143—258 mm The present specimens were in accordance with the known descriptions.

Stomach contents: 14, 4 empty.

The food consisted of only two items: fishes and plant matter; the two items made up an equal percentage of the volume (49% and 51%), Table 38.

Crenicichla lugubris ingested fishes and plant matter.

(43) *Crenicichla nanus* REGAN, 1913.
43 specimens (12) — Lago Calado.

Sd. l. 36.2—68.5 mm. Depth 6.0—7.0, head 3.0—3.2 in sd. l.; eye 3.3—4.1, i. o. 4.8—5.6 in the head. D XX—XXII 9—12, A III 8—9. Scales lat. 21—24 and 11—12, sc. longit. 57—66. Colouration: back homogenuously brown; a dark stripe reaches from the tip of snout (across the eye and operculum) to the end of the caudal fin, (on the flank the stripe was about 3—4 scales wide); in the upper part of the caudal base there was a small ocellus.

Here, for the first time, *Crenicichla nanus* REGAN, 1913 was reported from the environment of Manaus, Brazil.

Stomach contents: 21, 3 empty.

Some of the stomachs were well preserved. The contents showed only a few items which could not be identified.

Ephemeroptera larvae (38%) made up easily the largest percentage. The larvae were found in 66% of the stomachs examined. Trichoptera larvae (subimagines) were found in 23% of the stomachs examined; 12% of the volume in a mean stomach contents, nearly as frequent as fishes (12% of the volume). But other items were eaten in smaller quantities: aquatic Coleoptera (5%), Diptera (6%), Lepidoptera and Odonata larvae,

as well as one decapod (Crustacea 3%). Plant matter (8%) and detritus (6%) may be ingested along with the larvae (Table 39).

Crenicichla nanus ingested larvae of insects (Ephemeroptera and Trichoptera), and fishes.

(44) *Crenicichla notophthalmus* REGAN, 1913
24 specimens (14) — Lago Calado.

Sd. l. 36.1—59.0 mm. Depth (measured at the beginning of the dorsal fin) 6.2—6.7, head 3.0—3.2 in sd. l.; eye 3.2—3.6, i. o. 4.4—5.7 in the head. D XX—XXII 9—11, A III 8—9. Scales lat. 22—24 and 10—13, sc. longit. (60)—64. Colouration: dark stripe reaching from the tip of snout (across the eye) to the operculum; in the dorsal fin a larger black spot (15th—18th ray), sometimes the spot appeared to be divided, so that 2 spots were visuable in the dorsal fin.

Stomach contents: 14, 2 empty.

The numerous items in one stomach were well recognizable. In half of the stomachs examined Ephemeroptera nymphs (36%) were found. These together with Trichoptera (18%), Odonata (13%), and Diptera (5%), (chironomids which were found in 21% of the stomachs examined), made up 73% of the food. In addition, there were fishes (20%) and aquatic beetles (6%), as well as one decapod. Detritus and plant matter were wholly missing (Table 40).

Crenicichla notophthalmus ingested larvae of insects (Ephemeroptera and Trichoptera), and sometimes fishes.

(45) *Crenicichla ornata* REGAN, 1905
8 specimens (7) — Lago Calado.

Sd. l. 95—216 mm. Depth 4.8—(6.0), head 3.0—3.2 in sd. l.; eye 5.8—6.1, i. o. 3.6—4.7, snout 2.4—3.0 in the head. D XXII—XXIV 17—19, A III 11—13. Scales lat. 28 and 15—18, sc. longit. 112—119. The colouration was exactly in accordance with the figure given by REGAN (1905b, Table XV, fig. 2).

It remains for the examinations of other extensive collections of material to answer the question, whether *Crenicichla ornata* REGAN, perhaps, may be identical to *C. lenticulata* HECKEL.

Stomach contents: 5, none empty.

Plant matter (45% of volume) was to be found in 4 stomachs. One fish each ingested a fish (20%), a decapod (18%) or an Ephemeroptera larvae (18%).

(46) *Crenicichla saxatilis* (LINNAEUS, 1758)
Jacundá; 10 specimens — Ig. Barro branco, 24 specimens (12) — Lago Calado.

Sd. l. 36.2—178 mm. Depth 4.8—5.5 in adults, (5.5—6.1 in juvenile forms), head 2.8—2.9 (2.5 to 3.0) in sd. l.; eye 4.4—6.0 (3.3—4.2) in the head. D XVIII—XX 11—13, A III 7—10. Scales lat. 21—23 and 11—13. Colouration: a dark stripe runs from the tip of snout above the outermost margin of operculum, produced to a humeral spot above the pectoral fin, but below the lateral line; below the eye a dark triangle. Dorsal fin with light submarginal band repeated in the caudal fin, an ocellus at the upper part of caudal base. The specimens from Ig. Barro branco did not differ from those named above.

Stomach contents:

Ig. Barro branco — 6, ? empty. The stomachs were well-preserved. Their contents consisted of fishes (50%) which were considerably digested, and of Ephemeroptera

larvae. One stomach was filled with leafy remains. Four other specimens from the year 1967 verified this result.

Lago Calado — 10, 2 empty. The food items were often reduced into small pieces. Ephemeroptera larvae (29%), Odonata, Lepidoptera and Diptera larvae made up, along with chitinous remains (16%), the largest percentage (54%). Further, the plant matter (29%) was important, being found in half of the stomachs examined. There were fishes (17%) in 3 stomachs (Table 41).

Crenicichla saxatilis ingested equally Ephemeroptera larvae and plant matter; fishes occurred frequently.

(47) *Cichlasoma festivum* (Heckel, 1840)
106 specimens (10) — Lago Calado.

Sd. l. 18.1—118 mm.

Stomach contents: 46, none empty.

84% of the food originated from plants. Out of this, 46% fruits and 7% coarse litter could be differenciated. In addition, the great variability of food items was conspicuous. The following items occurred only accidentally: fishes, Trichoptera larvae, Coleoptera, and Formicoidea (Table 42).

Cichlasoma festivum ingested plant matter and fruits.

(48) *Cichlasoma severum* (Heckel, 1840)
9 specimens (8) — Lago Calado.

Sd. l. 17.2—141.2 mm. Depth 2.8—3.2 (1.8—1.9 in total length), head 3.3 (2.7—2.9) in sd. l.; eye 2.7—3.5 in the head. Scales lat. 18—23 and 10—13, sc. longit. 34—39. Gill rakers 8—10.

Stomach contents: 7, 1 empty.

Only few determinable parts were found. Fruits (47%) were found in 71% of the stomachs examined, just as frequent as detritus (23% volume). Decapoda and ephippia (Crustacea 7%) and fishes (8%) made up the other items. The occurrence of algae and sand was notable.

(49) *Uaru amphiacanthoides* Heckel, 1840
Uarú; 1 specimen — Lago Calado.

Sd. l. 120.6 mm (total 155 mm). The meristic data, the number of rays and scales, and the colouration were in accordance with the data given by Regan, 1905c: 439.

Stomach contents: The intestines were rotted. Only sand and detritus were recognizable.

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	0.42	8.1		17	22.1
Hymenoptera	0.01	0.3		1	1.3
Isoptera					
terr. Coleoptera	0.10	2.4		7	9.1
Diptera					
Arachnea					
fruits		1.8		2	2.6
coarse litter					
plant matter		14.0		34	44.0
chitinous remains		1.7		3	3.9
detritus		4.8		11	14.3
aquat. Coleoptera					
Hemipteroidea	0.02	0.6		3	3.9
larvae: Ephemeroptera	2.60	18.6		49	63.8
Odonata	0.10	2.0		8	10.4
Trichoptera	1.40	18.1		56	73.0
Lepidoptera	0.06	0.6		2	2.6
Coleoptera	0.10	2.0		10	13.0
Diptera	3.61	10.0		41	53.1
sand		1.7		6	7.8
algae					
Hydracarina	0.10	0.5		4	5.2
Crustacea	0.07	7.6		12	15.8
fishes	0.07	5.2		10	13.0
		100.0			358.9

Table 31 Aequidens tetramerus

Tarumã, 77 indiv., 21.3 – 145.4 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	0.10	5.4		8	11
Hymenoptera					
Isoptera					
terr. Coleoptera	0.21	3.9		10	14
Diptera	0.01	0.2		1	1
Arachnea					
fruits					
coarse litter					
plant matter		13.3		31	42
chitinous remains					
detritus		5.0		14	19
aquat. Coleoptera	0.02	1.4		2	3
Hemipteroidea	0.07	1.2		4	6
larvae Ephemeroptera	1.76	21.8		46	63
larvae Odonata	0.01	0.2		1	1
larvae Trichoptera	3.26	24.6		47	65
larvae Lepidoptera	0.01	0.2		1	1
larvae Coleoptera	0.20	3.5		10	14
larvae Diptera	4.60	11.8		36	50
sand		2.6		8	11
algae					
Hydracarina	0.01	0.1		1	1
Crustacea	0.02	1.7		4	6
fishes	0.02	3.5		6	8
		100.0			316

Table 32 Aequidens tetramerus

Tarumã (1967), 73 indiv., 19.3 – 157.0 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	0.39	3.6		17	21
Hymenoptera					
Isoptera		0.4		2	3
terr. Coleoptera					
Diptera		0.8		2	3
Arachnea					
fruits					
coarse litter					
plant matter		10.3		31	39
chitinous remains		1.8		4	5
detritus		3.1		8	10
aquat. Coleoptera	0.16	2.5		6	8
Hemipteroidea	0.33	4.6		14	18
larvae Ephemeroptera	3.28	18.6		58	74
larvae Odonata	0.26	5.0		13	17
larvae Trichoptera	5.62	26.6		63	80
larvae Lepidoptera		2.8		7	9
larvae Coleoptera	0.14	3.0		9	11
larvae Diptera	2.45	9.6		43	54
sand					
algae					
Hydracarina	0.21	1.0		11	14
Crustacea		1.9		7	9
fishes		5.7		10	13
		100.0			388

Table 33 Aequidens tetramerus

Barro branco, 79 indiv., 16 – 138 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		3.9		3	10
coarse litter					
plant matter		21.3		15	49
chitinous remains		6.7		5	16
detritus		31.4		16	51
aquat. Coleoptera		0.8		1	3
Hemipteroidea		4.8		2	6
larvae					
Ephemeroptera	1.50	20.4		8	26
Odonata		1.5		3	10
Trichoptera					
Lepidoptera	0.13	2.6		1	3
Coleoptera					
Diptera					
sand					
algae					
Hydracarina					
Crustacea	0.52	6.6		8	26
fishes					
		100.0			200

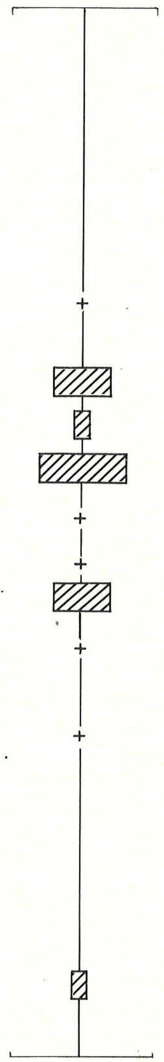

Table 34 Acaronia nassa

Lago Calado, 31 indiv., 23.0 – 82.8 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		27.3		3	27
coarse litter					
plant matter		60.0		7	54
chitinous remains		0.4		1	9
detritus					
aquat. Coleoptera					
Hemipteroidea					
larvae					
Ephemeroptera					
Odonata					
Trichoptera					
Lepidoptera					
Coleoptera					
Diptera					
sand					
algae					
Hydracarina		1.8		3	27
Crustacea		0.9		1	27
fishes		9.6		2	19
		100.0			144

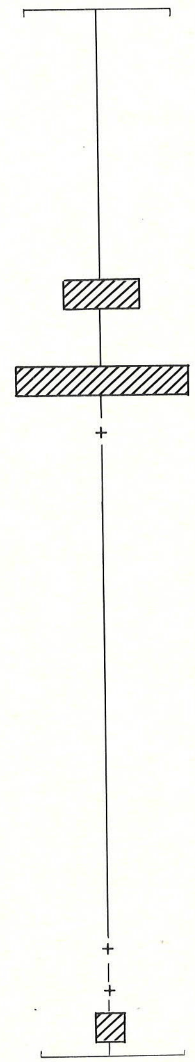

Table 35 Acarichthys heckelii

Lago Calado, 11 indiv., 34.3–99.6 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		23.0		11	40
coarse litter					
plant matter		19.4		12	44
chitinous remains		11.3		14	52
detritus		22.2		14	52
aquat. Coleoptera	0.03	0.2	+	1	4
Hemipteroidea					
larvae Ephemeroptera					
larvae Odonata					
larvae Trichoptera					
larvae Lepidoptera					
larvae Coleoptera					
larvae Diptera	1.68	2.2	+	6	22
sand					
algae					
Hydracarina	2.00	2.2	+	11	40
Crustacea	16.00	17.2		14	52
fishes	0.07	2.3	+	6	22
		100.0			328

Table 36

Geophagus jurupari

Lago Calado, 28 indiv., 19.9 – 77.2 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		10.4		3	25
coarse litter					
plant matter		22.5		6	50
chitinous remains		7.1		3	25
detritus		27.1		9	75
aquat. Coleoptera					
Hemipteroidea	0.08	0.8	+	1	8
larvae Ephemeroptera					
larvae Odonata					
larvae Trichoptera					
larvae Lepidoptera	0.16	3.8	+	2	17
larvae Coleoptera	0.58	5.4		4	33
larvae Diptera	0.50	2.9	+	2	17
sand		2.5	+	4	33
algae		1.7	+	1	8
Hydracarina	9.84	12.9		11	91
Crustacea	1.25	2.9	+	5	41
fishes					
		100.0			423

Table 37

Apistogramma agassizii

Lago Calado, 12 indiv., 18.0 - 31.1 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		51.0		8	57
chitinous remains					
detritus					
aquat. Coleoptera					
Hemipteroidea					
larvae					
Ephemeroptera					
Odonata					
Trichoptera					
Lepidoptera					
Coleoptera					
Diptera					
sand					
algae					
Hydracarina					
Crustacea					
fishes		49.0		6	43
		100.0			100

Table 38 *Crenicichla lugubris*

Lago Calado, 14 indiv., 178–257 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		7.8		5	24
chitinous remains		5.0		5	24
detritus		5.6		2	10
aquat. Coleoptera	0.16	5.0		2	10
Hemipteroidea					
larvae					
Ephemeroptera	2.48	37.5		14	67
Odonata	0.05	1.1	+	1	5
Trichoptera	0.27	12.8		5	24
Lepidoptera	0.05	3.9	+	1	5
Coleoptera					
Diptera	0.05	5.6		1	5
sand					
algae					
Hydracarina					
Crustacea	0.05	3.3	+	1	5
fishes	0.33	11.4		4	19
		100.0			198

Table 39 *Crenicichla nanus*

Lago Calado, 21 indiv., 36.2 – 67.8 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter					
chitinous remains					
detritus					
aquat. Coleoptera	0.36	5.8		1	7
Hemipteroidea					
larvae: Ephemeroptera	1.42	35.8		7	50
larvae: Odonata	0.21	13.8		3	21
larvae: Trichoptera	0.36	18.3		4	28
larvae: Lepidoptera					
larvae: Coleoptera					
larvae: Diptera	1.00	5.0		3	21
sand					
algae					
Hydracarina					
Crustacea	0.07	1.7	+	1	7
fishes	0.28	19.6		4	28
		100.0			162

Table 40

Crenicichla notophthalmus

Lago Calado, 14 indiv., 36.1 – 58.3 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume	percentage	number	percentage
Formicoidea					
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits					
coarse litter					
plant matter		28.8		5	50
chitinous remains		16.3		3	30
detritus					
aquat. Coleoptera					
Hemipteroidea					
larvae: Ephemeroptera	1.3	29.4		5	50
larvae: Odonata	0.1	2.5	+	1	10
larvae: Trichoptera					
larvae: Lepidoptera	0.2	4.3	+	1	10
larvae: Coleoptera					
larvae: Diptera	0.5	1.8	+	2	20
sand					
algae					
Hydracarina					
Crustacea					
fishes	0.3	16.9		3	30
		100.0			200

Table 41

Crenicichla saxatilis

Lago Calado, 10 indiv., 36.2 – 178.0 mm

mean stomach contents				of food items	
1	2	3	4	5	6
food items	number	volume percentage		number	percentage
Formicoidea	0.09	1.9		4	9
Hymenoptera					
Isoptera					
terr. Coleoptera					
Diptera					
Arachnea					
fruits		46.0		24	52
coarse litter		6.6		4	9
plant matter		31.3		19	41
chitinous remains		0.6		2	4
detritus		1.1		3	7
aquat. Coleoptera	0.13	2.5		5	11
Hemipteroidea					
larvae Ephemeroptera					
larvae Odonata					
larvae Trichoptera	0.06	1.0		3	7
larvae Lepidoptera					
larvae Coleoptera					
larvae Diptera					
sand		2.2		2	4
algae		3.5		2	4
Hydracarina					
Crustacea					
fishes	0.06	3.3		3	7
		100.0			155

Table 42

Cichlasoma festivum

Lago Calado, 46 indiv., 18.1 – 89.0 mm

It seems meaningful to report the investigations of stomach contents for the single fish species, rather than discussing and interpreting the results all at once, so that one can avoid overrating single results. Here, once more, it should be remembered that the fish material was not collected continuously, that assessment of volume naturally is less than exact, and that sufficient numbers of fishes were not always available.

Moreover, in this manner, the detailed reports of the stomach contents can better be used as an ecological contribution to the knowledge of these fishes. Now, an attempt is made to get an idea of the food of these fishes by summarizing the single results for many species. (For this, only "mean stomach contents" were employed.)

1. Stomach contents of single fish families

First, in separate tables, the species are listed in their order of taxonomic relationship, so that the discussion of stomach contents can be started. (Species of less than 10 individuals are marked with an asterik, in the Tables 43—47.)

The food items are not shown quantitatively if their volume in the mean stomach contents was smaller than 10%. Thus, those items are emphasized which have more importance in the diet of the fishes. If the items make up more than 50% of the volume, these are called the main food (Corbet, 1961, Petr, 1968). In addition, the intestinal ratios are listed (see below).

Characidae (Table 43): At once, it is conspicuous that nearly all species contained large percentages of detritus and vegetable remains, in addition, it is just as conspicuous that other — animal — items are eaten. Among the latter, ants are especially important to *Bryconops inpai* and *Hemigrammus ocellifer*.

Generally, Characidae are known as peaceable, but carnivorous fishes. The stomach contents do not disprove this, but the large percentages of vegetable remains and detritus do not permit us tò underrate those items.

There have been a few earlier indications of food habits in the Characidae: Ladiges, 1950, for *Hyphessobrycon callistus*; Randow, 1951; Geisler & Bolle, 1956, for *Bryconops (Creatochanes) affinis*.

Erythrinidae (Table 43): Both species picked up important items of food from near the bottom (larvae of insects, coarse litter, and sand); nevertheless, the percentage of fishes is so large, that the erythrinid fishes have to be considered predatory. This agrees with reports up to now. (Lowe (McConnell), 1964, Alexander, 1964). In contrast, no references could be found in the literature that significant amounts of the food are picked up from the bottom, or that the percentage of plant matter can be so large.

Lebiasinidae (Table 44): Conspicuously, the species of the two subfamilies Pyrrhulininae and Nannostominae eat differently. *Pyrrhulina brevis* and *Copella nattereri* eat predominantly animal food (Alexander, 1964). In this, the large percentage of ants is notable. In contrast, the species of *Poecilobrycon* nearly exclusively eat plant matter, among which are notable percentages of algae.

Anostomidae (Table 44): It appears that these specimens of *Leporinus friderici* not only ingested plant matter but also fish remains (carrion ?).

Unfortunately only this one species represents the Anostomidae. Generally, the Anostomidae must be considered plant eaters. (LADIGES, 1951, ALEXANDER, 1964.)

Curimatidae (Table 44): Only few species are available. They verify that species of this family pick up their food from the bottom. Large percentages of sand are always found in the guts.

Along with sand, detritus and algae (Diatomeae) are ingested, and incidental larvae, too (AZEVEDO et. al., 1938).

Crenuchidae (Table 44): *Crenuchus spilurus* picked up mainly detritus, but Crustacea and Ephemeroptera larvae are important items.

Gymnotoidei (Table 45): The species of the families Gymnotidae and Rhamphichtyidae present eat larvae of insects, and plant matter was always found. There were percentages of fish and Crustacea in *Gymnotus carapo*; in *Gymnotus anguillaris* there were percentages of ants.

Early reports on the food of gymnotid fishes exist, because these fishes were often investigated for their anatomical und physiological specialization (electric organs). In 1913, M. M. ELLIS gave detailed data on stomach contents. He found differences in the food which were related to size and mouth shape of the fishes. His counts of food items agree exactly with the results on the present material from the Rio Negro region. He found:

Gymnotus carapo: mainly larvae of insects, but also fishes and Crustacea.

Sternopygus macrurus: mainly imagines of insects, among them some terrestrial beetles and bugs, but insect larvae were again quite most important.

Eigenmannia macrops: larvae of insects and Crustacea.

Steatogenes elegans: Crustacea and larvae of insects.

ELLIS was not able to investigate the stomachs of *Gymnorhamphichthys hypostomus*.

This material from Guiana was notable for the large amount of small Crustacea, and that the selection of food depends on the size of the fishes.

Siluriformes (Table 45): *Helogenes amazonae* is surprising with its large percentage of ants and beetles. It is known that *H. marmoratus* picks up food in sandy or muddy bottoms (STERBA, 1959). *Callichthys callichthys* and *Rhamdia sp.* find their food in or on the bottom, as the fraction of insect larvae and detritus shows. Nevertheless, Crustacea and fishes are also picked up. Also ants and termites can be found (in *Rhamdia*).

Cichlidae (Table 46 and 47): The larger species of Cichlidae (*Crenicichla, Cichla ocellaris*) eat other fishes; only in the dwarf cichlid, *Apistogramma agassizii*, were no fishes found. In spite of this, fishes cannot be considered the main food of the Cichlidae, because larger percentages of plant matter or fruits were always eaten. This indicates the great variability of food selected by the cichlids. *Cichlasoma festivum* and *C. severum* eat mainly fruits, but the exceedingly high percentage of vegetable food is accompanied by fishes and Crustacea. This is well-marked in *Crenicichla lugubris* (Table 47). The *Crenicichla* species may tend towards a carnivorous diet, as indicated by the Ephemeroptera and Trichoptera larvae. For the remaining species (Table 47) the vegetable percentages are

	Characidae								Erythrinidae	
	Brycon melanopterus	Iguanodectes tenuis	Bryconops inpai	Hemigrammus ocellifer	Hyphessobrycon bellotti	Moenkhausia ceros	Moenkhausia lepidura	Megalamphodus micropterus	Hoplerythrinus unitaeniatus	Hoplias malabaricus
Formicoidea	+		▨	▨	+		+			
Hymenoptera			+		+	+	+			
Isoptera			+							
terr. Coleoptera			+	+						
Diptera			+							
Arachnea			+		+					
fruits	+	+	+	+		+	+			
coarse litter	▨	▨		+		▨		+		▨
plant matter	▨	▨	+	▨	▨	▨	▨	+	+	▨
chitinous remains			+	+	▨	+	+	▨		
detritus	▨	▨		▨	▨	▨	▨	▨		
aquat. Coleoptera			+	+	+		+	▨	+	
Hemipteroidea			+	+	+	+	+			
larvae										
Ephemeroptera			+	▨	▨	+	+	+	▨	
Odonata				+						
Trichoptera			+		+				▨	
Lepidoptera			+		+				▨	
Coleoptera				+			+		+	
Diptera					+			+		
sand	+			+		+	+			▨
algae		▨		+		+	+			
Hydracarina				+						
Crustacea				+	+			+		
fishes	+		+						▨	▨
intestinal ratio	0.8	1.0	0.6	0.6	0.6	0.4	0.4	0.4	0.6	0.6

Table 43. Mean stomach contents (volume percentages) of Characidae and Erythrinidae. (Volumes of items smaller than 10% are marked with a cross.)

	Lebiasinidae				Anostomidae	Curimatidae				Crenuchidae
	Poecilobrycon eques *	Poecilobrycon unifasciatus	Copella nattereri	Pyrrhulina brevis	Leporinus friderici	Chilodus punctatus *	Curimata spilura *	Curimata latior *	Prochilodus theraponura *	Crenuchus spilurus
Formicoidea			▨	▨						
Hymenoptera			+	+						
Isoptera			+	+						
terr. Coleoptera			+	+						
Diptera				+						
Arachnea				+						
fruits			+	+	+					
coarse litter					▨					
plant matter		▨	+	+	▨		+			+
chitinous remains		+		+						▨
detritus	+	▨	▨			+	▨			▨
aquat. Coleoptera				+						
Hemipteroidea			+	+						
larvae: Ephemeroptera			▨	+		+				▨
larvae: Odonata			+							
larvae: Trichoptera			+	+						+
larvae: Lepidoptera			+							
larvae: Coleoptera			+							
larvae: Diptera			+			+				
sand		+			+	+	▨	+	+	
algae	+	+	+						+	
Hydracarina				+						+
Crustacea				+	▨					▨
fishes					▨					
intestinal ratio	0.9	1.0	0.6	0.8	1.0	1.0	5.0	4.0	–	0.4

Table 44. Mean stomach contents (volume percentages) of the Lebiasinidae, Anostomidae, Curimatidae, and Crenuchidae. (Volumens of items smaller than 10% are marked by a cross.)

	Gymnotoidei						Siluriformes	
	Gymnotus carapo *	Gymnotus anguillaris	Sternopygus macrurus *	Gymnorhamph= ichthys sp. *	Eigenmannia macrops *	Steatogenes elegans *	Helogenes amazonae *	Callichthys callichthys
Formicoidea		+					▨	
Hymenoptera								
Isoptera								
terr. Coleoptera							+	
Diptera		+						
Arachnea								
fruits								+
coarse litter								
plant matter	▨	+	+	+		+		▨
chitinous remains		+	▨					
detritus		+	+			▨		+
aquat. Coleoptera		+	▨	+				+
Hemipteroidea			+			+		+
larvae: Ephemeroptera		▨	▨	+		+		▨
larvae: Odonata	+	+						
larvae: Trichoptera		▨	▨	▨	+			▨
larvae: Lepidoptera		+						
larvae: Coleoptera		+		+				+
larvae: Diptera		+	+	▨	+	▨		▨
sand						+		
algae								
Hydracarina								+
Crustacea	▨	+				+		+
fishes	▨							+
intestinal ratio	–	0.4	–	0.2	–	0.3	0.4	0.8

Table 45. Mean stomach contents (volume percentages) of the Gymnotoidei, Siluriformes. (Volumens of items smaller than 10% are marked with a cross.)

Table 46.
Mean stomach contents (volume percentages of the Cichlidae. (Volumes of items smaller than 10% are marked with a cross.)

	Cichlidae						
	Monocirrhus polyacanthus *	Cichla ocellaris *	Aequidens tetramerus	Acaronia nassa	Acarichthys heckelii	Geophagus jurupari	Apistogramma agassizii
Formicoidea			+				
Hymenoptera			+				
Isoptera							
terr. Coleoptera			+				
Diptera							
Arachnea							
fruits			+	+	▨	▨	▨
coarse litter							
plant matter			▨	▨	▨	▨	▨
chitinous remains			+	+	+	▨	+
detritus			+	▨		▨	▨
aquat. Coleoptera				+		+	
Hemipteroidea			+	+			+
larvae: Ephemeroptera			▨	▨			
larvae: Odonata			+	+			
larvae: Trichoptera			▨				
larvae: Lepidoptera			+	+			+
larvae: Coleoptera			+				+
larvae: Diptera			▨			+	+
sand			+				+
algae			+				+
Hydracarina			+		+	+	▨
Crustacea			+	+	+	▨	+
fishes	+	+	+		+	+	
intestinal ratio	–	–	0.8	0.9	1.0	1.1	0.8

	Cichlidae							
	Crenicichla johanna *	Crenicichla lugubris	Crenicichla nanus	Crenicichla notophthalmus	Crenicichla ornata *	Crenicichla saxatilis	Cichlasoma festivum	Cichlasoma severum
Formicoidea								
Hymenoptera								
Isoptera								
terr. Coleoptera								
Diptera								
Arachnea								
fruits							▨	▨
coarse litter							+	
plant matter	▨	▨	+		▨	▨	▨	+
chitinous remains	+		+			▨	+	+
detritus			+				+	▨
aquat. Coleoptera			+	+			+	
Hemipteroidea	▨							
larvae: Ephemeroptera	▨		▨	▨	▨	▨		
larvae: Odonata			+	▨		+		
larvae: Trichoptera			▨	▨			+	
larvae: Lepidoptera			+			+		
larvae: Coleoptera			+					
larvae: Diptera			+	+		+		
sand							+	+
algae							+	+
Hydracarina								
Crustacea			+	+	▨			+
fishes	▨	▨	▨	▨	▨	▨	+	+
intestinal ratio	0.6	0.6	0.5	0.4	0.6	0.6	1.0	1.0

Table 47. Mean stomach contents (volume percentages) of the Cichlidae. (Volu
of items smaller than 10% are marked with a cross.)

very much larger than the incidential occurrence of insect larvae, fishes or Crustacea. The large percentage of Hydracarina in *Apistogramma agassizii* is surprising (Table 46).

The Cichlidae examined indicate that these fishes are able to eat many different items. *Aequidens tetramerus* is a very good example of this. In their stomachs are to be found ants. plant matter, larvae of insects, algae, and fishes.

Surprisingly, data are rare in the literature on the food of South American cichlids, except for the well known predator (e. g. *Cichla ocellaris*). According to STERBA, 1959: 490, all cichlid species should be predator except the species of *Geophagus* and *Tilapia.* A very small study, done by R. S. MENEZES, 1961, showed that *Crenicichla saxatilis* feeds on algae and insects. In that paper other authors are cited: *Crenicichla lenticulata* feeds on detritus and insects; *Crenicichla lacustris* feeds on fishes and Crustacea.

Comparing the stomach contents of the various families, a certain uniformity in the selection of food is evedent. Distinct specialists, or, at least fish species feeding nearly exclusively on one group of animals or plants, are not to be found among the fishes at hand from the various localities in the Rio Negro region. In contrast, most species indicate a more or less great variability in food selected. This trend can be observed in all families of fishes examined.

2. Anatomical and morphological notes

The diet of an animal depends not only on the supply of food, that is, on his environment, but also on his abilities to make use of the food. For this reason, possibly, the shapes or ways of life became more and more specialized.

Before beginning discussion of the supply of food, several short morphological and anatomical notes should be given on: a) forms of the snout, denture, and teeth; b) stomach and intestine; and c) intestinal ratio.

a) forms of the snout, denture and teeth

There are some excellant studies on the skulls and teeth of Characoidei. Most studies deal with systematics and phylogenesis (GREGORY & CONRAD, 1938, WEITZMAN, 1954, 1962, GERY, 1961, ROBERTS, 1967).

Considering the possible function in picking up the food, ALEXANDER, 1964, examined several skulls of Characoidei. At this place, a short review may be permitted: *Bryconops (Creatochanes) affinis, Brycon falcatus, Pyrrhulina sp., Leporinus friderici, (Poecilobrycon sp.), Hoplias,* (and additional *Myleus, Serrasalmus, Anisitsia*) were examined.

The forms, the positions and the numbers of teeth permit the recognition of at least two functions: shearing or holding and crushing prey. The food was related to this; according to the occurrence of teeth, leafy remains or insects (or other prey) were found, and sometimes both items. In addition, the intake of food depended on the cranial structure. The terminal mouth of *Leporinus friderici* seems to be poorly adapted, since it must stand on its head to take food.

Curimatidae, feeding on sand and detritus, are without teeth. For the Gymnotidae, ELLIS, 1913, reported a relation between the manner of ingestion and the form of the snout and length of the body. Large-mouthed species (*Gymnotus, Sternopygus*) feed on Malakostraca and fishes; species with smaller mouths (*Steatogenes, Eigenmannia*) feed on Entomostraca, larvae of insects, or even imagines. Tubular-mouthed species (*Gymnorhamphichthys*) feed on animals from the bottom (annelids, insect larvae). Anatomical investigations of some silurid families are known from EIGENMANN, 1918, 1925; GREGORY, 1933, ALEXANDER, 1966. They do not consider the function of skulls in ingestion, however.

In contrast to the Loricariidae, which have a disklike mouth on the belly, the Pimelodidae and Callichthyidae examined have a normally formed, terminal mouth. There is a wide band of villiform teeth on the premaxillary and dentary (*Rhamdia*) or only on the dentary (*Callichthys*) so that smaller prey can be crushed and held.

For the Percoidei, GOSLINE, 1966: 416 gave general data on the feeding mechanism. Often there is a large mouth with conical teeth, usually in bands, in the Cichlidae which can hold and crush the prey well. Rather moveable and widely open jaws permit them to swallow whole animals.

b) stomach and intestine

There are older anatomical studies on the Characoidei, Siluriformes, and Percoidei (ROWNTREE, 1903, 1906; RAUTHER, 1911, JACOBSHAGEN, 1913, 1915) describing the morphological and sometimes the functional structure of single parts of the stomach and gut. JACOBSHAGEN examined the relation between the dietary habits and the morphology of the instestine. He did not find any regularity, however, for example, in the length of the intestine or the number of pyloric appendages, so that he only could mark the tendency that herbivorous fishes have longer intestines than carnivorous ones. SCHNAKENBECK, 1955, cited the rule valid for other vertebrates, that plant eaters have longer intestine than predator. He encouraged others to examine additional fish material, because at that time, very many exceptions to the "rule" were indicated.

For this purpose, drawings of nearly all species examined were made, to show the forms of the stomachs and the courses and length of the intestines; the number of pyloric appendages is indicated.

Only typical and the strongly differing intestines are shown (Fig. 3), because many figures are very similar, e. g. species of Tetragonopterinae. (In the drawings are to be noted: the ventral view (left lateral) is always shown; the gullet is always at the top; the single parts of the alimentary canal are in proper proportions, the scale given marks 5 mm.)

Characoidei: *Bryconops inpai* (5 pyloric app.) one coil around the stomach sac. In *Moenkhausia ceros* (8—10 pyloric app.) *Hemigrammus ocellifer* (9—12 pyloric app.) and *Hyphessobrycon bellotti* (6—8 pyloric app.), this single coil is very small and covers only the end of the stomach sac (Fig. 3, A, B). *Hoplias malabaricus* (numerous pyloric app.; those in *Hoplerythrinus* are more heavy and less numerous), Fig. 3, C (see JACOBSHAGEN, 1913: 466).

Poecilobrycon unifasciatus (3—4 pyloric app.), one coil of the gut around the whole stomach (Fig. 3, D).

Pyrrhulina brevis (10—12 pyloric app.), a small, round stomach sac which was, depending on the fullness, more or less thick or thin walled. The intestine was produced very long to the anus, and had one coil (Fig. 3, E).

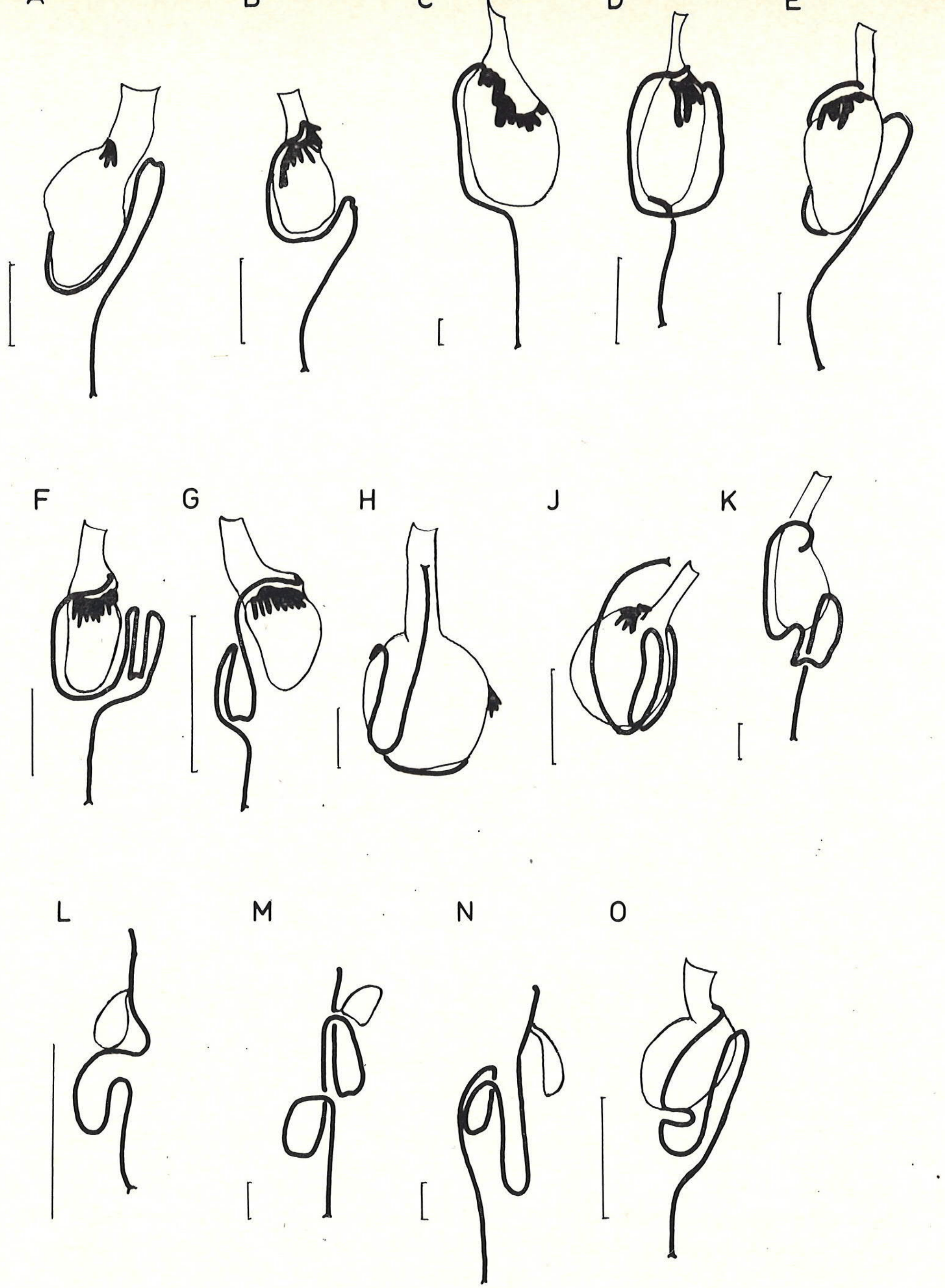

Fig. 3: Alimentary tract, semi-schematic; (courses and length of the intestines; the number of pyloric appendages is only representative; the scale marks 5 mm.)
Bryconops inpai (A), *Hemigrammus ocellifer* (B), *Hoplerythrinus unitaeniatus* (C), *Poecilobrycon unifasciatus* (D), *Pyrrhulina brevis* (E).
Chilodus punctatus (F), *Crenuchus spilurus* (G), *Gymnotus anguillaris* (H), *Sternopygus macrurus* (J), *Rhamdia sp.* (K).
Aequidens tetramerus (L), *Geophagus jurupari* (M), *Crenicichla saxtilis* (N), *Cichlasoma festivum* (O).

Curimatus spilurus, in juvenile forms, there were only a few concentric coils on the stomach sac (see Jacobshagen, 1913: 474) *Chilodus punctatus* (12—16 pyloric app.), one coil doubled on the side of the stomach (Fig. 3, F); (see Jacobshagen for *Prochilodus*).

Iguanodectes tenuis, alimentary canal is very similar to that of the Tetragonopterinae.

Crenuchus spilurus (12—14 pyloric app.), a small, lateral stomach sac (Fig. 3, G).

Gymnotoidei: *Gymnotus anguillaris* (6 pyloric app.) Fig. 3, H.

Sternopygus macrurus (1—2 pyloric app.) Fig. 3, J, (see Jacobshagen, 1913: 476).

Gymnorhamphichtys hypostomus (2 pyloric app.).

Steatogenes elegans (5 pyloric app.).

In all Gymnotoidei the coils of the intestines are very similar. The gut is coiled first around the end of the stomach sac, then goes along the whole sac, and is elongated near the opening of the gullet.

Siluriformes: *Rhamdia sp.* (no pyloric app.). The intestine is simply coiled around the stomach and then curls at the end of the stomach. The small intestine is short and muscular (Fig. 3, K). *Callichthys callichthys* (no pyloric app.). One coil of intestine on the stomach area (a real stomach not identifiable); small instestine and part of the large intestine very muscular, the walls of intestines membranous and bristled; this is related to the respiration in the gut (Rauther, 1911).

Percoidei: The Cichlidae are very similar in their alimentary canal. The stomach sac is usually small and reduced compared to the gullet and the strong large intestine. The middle part of the intestine is double-coiled; pyloric appendages were not found. *Aequidens tetramerus* (Fig. 3, L), *Geophagus jurupari* (Fig. 3, M), *Crenicichla saxtilis* (Fig. 3, N), and *Cichlasoma festivum* (Fig. 3, O).

c) intestinal ratio

The ratio of the length of the intestine to the standard length of the fish is called the intestinal ratio. No correlation between ingested food and this ratio can be noted. Even in the Characidae, in which feeding was very similar, (*Brycon melanopterus*, *Moenkhausia ceros*), the ratios are very variable (Table 43); only in the Cichlidae can the tendency be observed, that those species feeding on large percentages of vegetable remains (*Geophagus*, *Cichlasoma*) have longer intestines (Table 46) than, e. g., *Crenicichla notophthalmus* (Table 47), which feeds on animals. The Gymnotoidei (Table 45) have relatively short intestines (0.2—0.5 intestinal ratio), which definitely depends on the extraordinar length of the body. *Rhamdia* and *Callichthys*, which also feed on insect larvae and plant matter, show a longer intestine (0.8 intestinal ratio), Table 45.

In this review of morphological structures of stomachs and intestines, the older studies (see Jacobshagen, 1913, 1915) are verified. The characteristics varied so much, that a relation to the feeding of the fishes cannot be established. The morphology of the alimentary canal (stomach and intestine) cannot be used exactly as an index to the feeding habits, as shown by the irregularity in the length of intestine and the general uniformity of coils in the families, as well as the irregular number of the pyloric appendages (Har-

DER, 1960). Rather, additional facts must be considered which cannot be observed. HIRSCH, 1950, emphasized the *Vorverdauung*, consisting in crushing the food intensively in the mouth or breaking down the food enzymatically in the large intestine.

There are gaping holes in the knowledge of the pharyngeal teeth in the Characoidei, but their importance is already known in the Cyprinoidei (WUNDER, 1936, HARDER, 1964). Also the gill rakers must be considered to reflect the feeding habits.

In the present ecological-limnological study data on the anatomy are rather cursory, and can only indicate how necessary other investigations are.

3. Food items

To illustrate the importance of single food items, the fish species are brought together which ingested one (or more) of the food items which were quantitatively or qualitatively conspicuous (Table 48).

a) sand

Curimatus spilurus and *C. latior* made their diet of the fine, almost muddy sand (nearly 40%); as did *Chilodus punctatus* and *Prochilodus theraponura*. These fishes picked up fine detritus along with sand and sometimes insect larvae (see GNERI & ANGULESCU, 1951). Large percentages of sand were also found in those fishes which ingested coarse litter (*Hoplias malabaricus*, 20%, and *Brycon melanopterus*). In other species sand was found, but it was probably ingested along with the Diptera and Trichoptera larvae, in which case it does not pass for a special food item. The small number of specimens examined of *Curimatus* and *Chilodus* did not allow a listing of their species under "sand".

b) insect larvae

In 27 species occurred at least some kind of larvae. Thus, the great importance of this item in the diet of the fishes is clear. Furthermore, larvae appear to be the main food in 9 species; they make up 20% in an other 5 species. Splitting the insect larvae into Diptera, Ephemeroptera, and Trichoptera does not indicate a clear preference of the one or the other larvae, in any fish species (Table 48).

c) detritus

In 19 species detritus occurred clearly. It is true, however, that the volumes are mostly less than 50%. The very small species, such as *Megalamphodus micropterus*, *Poecilobrycon unifasciatus*, and *Crenuchus spilurus* ate detritus as their main food. (The Curimatidae cannot be included of the low number of specimens.)

Difficulties in identifying detritus, prohibit consideration of species with small volumes (less than 5%) in the table (*Pyrrhulina brevis*, *Gymnotus anguillaris*, *Sternopygus macrurus*, *Callichthys callichthys*, *Cichlasoma festivum*, and *Crenicichla nanus*), Table 48.

d) algae

They were only found in small quantities, so that quantitive discussion is rather limited. Nevertheless it is important enough to indicate the occurrence of algae (diatoms

Table 48. Food items important to the diets of the fishes. (The fishes are listed which ingested the named food items; those species with the names in spaced lettering ingested the food items as main food.)

INSECT LARVAE	DETRITUS	ALGAE	PLANT REMAINS
Bryconops inpai	Brycon melanopterus	Iguanodectes tenuis	Brycon melanopterus
Hemigrammus ocellifer	Iguanodectes tenuis	Hemigrammus ocellifer	Iguanodectes tenuis
Hyphessobrycon bellotti	Hemigrammus ocellifer	Moenkhausia lepidura	Bryconops inpai
Moenkhausia ceros	Hyphessobrycon bellotti	Poecilobrycon eques	Hemigrammus ocellifer
Moenkhausia lepidura	Moenkhausia ceros	Poecilobrycon unifasciatus	Hyphessobrycon bellotti
Megalamphodus micropt.	Moenkhausia lepidura	Copella nattereri	Moenkhausia ceros
Hoplerythrinus unit.	Megalamphodus micropterus	Prochilodus theraponura	Moenkhausia lepidura
Pyrrhulina brevis	Poecilobrycon unifasc.	Apistogramma agassizii	Megalamphodus micropt.
Copella nattereri	Copella nattereri	Cichlasoma festivum	Hoplias malabaricus
Chilodus punctatus	Chilodus punctatus	Cichlasoma severum	Hoplerythrinus unitaeniatus
Crenuchus spilurus	Curimatus spilurus		Poecilobrycon unifasciatus
Gymnotus carapo	Prochilodus theraponura		Pyrrhulina brevis
Gymnotus anguillaris	Crenuchus spilurus		Leporinus friderici
Sternopygus macrurus	Steatogenes elegans		Rhamdia sp.
Gymnorhamphichthys hypostomus	Sternopygus macrurus		Aequidens tetramerus
Callichthys callichthys	Rhamdia sp.		Acaronia nassa
Rhamdia sp.	Callichthys callichthys		Acarichthys heckelii
Aequidens tetramerus	Acaronia nassa		Geophagus jurupari
Acaronia nassa	Geophagus jurupari		Apistogramma agassizii
Geophagus jurupari	Apistogramma agassizii		Crenicichla johanna
Apistogramma agassizii	Cichlasoma severum		Crenicichla lugubris
Crenicichla johanna			Crenicichla ornata
Crenicichla nanus			Crenicichla nanus
Crenicichla notophth.			Crenicichla saxatilis
Crenicichla saxatilis			Cichlasoma festivum
			Cichlasoma severum

CRUSTACEA	FISHES	ANTS
Hemigrammus ocellifer	Brycon melanopterus	Brycon melanopterus
Hyphessobrycon bellotti	Hoplias malabaricus	Bryconops affinis
Megalamphodus micropt.	Pyrrhulina brevis	Bryconops inpai
Hoplerythrinus unitaeniatus	Hoplorythrinus unitaeniatus	Hemigrammus ocellifer
Pyrrhulina brevis	Leporinus friderici	Hyphessobrycon bellotti
Leporinus friderici	Gymnotus carapo	Moenkhausia lepidura
Crenuchus spilurus	Callichthys callichthys	Pyrrhulina brevis
Gymnotus carapo	Rhamdia sp.	Copella nattereri
Gymnotus anguillaris	Monocirrhus polyac.	Gymnotus anguillaris
Steatogenes elegans	Cichla ocellaris	Helogenes amazonae
Callichthys callichthys	Aequidens tetramerus	Rhamdia sp.
Rhamdia sp.	Acarichthys heckelii	Aequidens tetramerus
Aequidens tetramerus	Crenicichla johanna	Cichlasoma festivum
Acaronia nassa	Crenicichla lugubris	
Acarichthys heckelii	Crenicichla nanus	
Geophagus jurupari	Crenicichla notophthalmus	
Apistogramma agassizii	Crenicichla ornata	
Crenicichla nanus	Crenicichla saxatilis	
Crenicichla notophthalmus	Cichlasoma festivum	
Crenicichla ornata	Cichlasoma severum	
Cichlasoma severum		

and filamentous algae) in this way. The algae were found nearly exclusively in the fishes from the Lago Calado. In *Iguanodectes tenuis* and *Poecilobrycon unifasciatus* primarily filamentous algae occurred. In contrast, diatoms occurred in *Prochilodus theraponura* and *Copella nattereri* (Table 48).

e) plant remains

In more than 26 species, remains of plants occurred (coarse litter, fruits, and plant matter are not differentiated in Table 48). Using this data, fishes are brought together which lived in different places, as shown by the preference for coarse litter or fruits. *Bryconops inpai*, *Pyrrhulina brevis*, and several Cichlidae preferred coarse litter. (Since in "plant matter", those remains of stems and leaves are put together which cannot clearly determined as coarse litter or fruits: it is possible that these fractions are actually larger.)

This fraction (less than 5%) cannot be considered in Table 48 for the following species: *Megalamphodus micropterus*, *Copella nattereri*, *Gymnotus anguillaris*, *Sternopygus macrurus*, *Gymnorhamphichthys hypostomus* and *Callichthys callichthys*).

f) Crustacea

In 21 species, Crustacea occurred. Among them Copepoda and Ostracoda are counted, as well as Decapoda (Palaemonidae) and ephippia (Cladocera). The percentages are generally small. Only *Hoplerythrinus unitaeniatus* indicates an important percentage of decapods (45%). It is conspicuous that no active Crustacea (only ephippia) occurred in the Characidae (sens. str.), Table 48.

Possibly the single ephippia were ingested with the coarse litter or remained in the gut for a longer period than the Cladocera themselves, because in waters extremely poor in lime, the cladoceran exoskeleton is very soft and quickly digested.

g) fishes

In 20 species, whole fishes, scales or flesh remains occurred. The percentages were partly very large. The main food of *Monocirrhus polyacanthus* and *Cichla ocellaris* is known to be fishes. This was verified by the only two specimens of each at hand. Otherwise, fishes were only eaten by the larger Characoidei and the Cichlidae examined. (In siluriform and gymnotid fishes only a small percentage of fishes was to be observed, and their importance to the diets must have been very small.) Table 48.

h) ants

In 13 specimens, ants (Formicoidea) occurred. The ants have great significance in the diets of some fish species. *Pyrrhulina brevis* even ingested them as its main food. In addition, *Bryconops inpai* (43%), *Hyphessobrycon bellotti*, *Hemigrammus ocellifer*, and *Helogenes amazonae* fulfill their food needs with ants. Apart from this, ants occurred in several other species: *Brycon melanopterus*, *Bryconops affinis*, *Moenkhausia lepidura*, *Copella nattereri*, *Gymnotus anguillaris*, *Rhamdia sp.*, *Aequidens tetramerus*, and *Cichlasoma festivum*. Often other terrestrial insects (termites, beetles, flies, and midges) were eaten; thus these allochthonous food items taken together, attain great importance (Table 48).

Finding terrestrial insects in the stomachs of fishes is not unusual. GEISLER & BOLLE, 1956, reported from Argentina, PETR, 1967, from Africa (Lake Volta), and GEISLER, 1967 a, from Ceylon that some fish species preferred terrestrial insects.

Some other food items should be noted although they remained unimportant in their volume percentage and occurrence.

Hydracarina

In 10 species, Hydracarina occurred. They are rejected by the central European fishes. *Apistogramma agassizii* ingested 13%. In the other species, Hydracarina mostly made up less than 5% of the volume. Probably Hydracarina were ingested only along with other items (*Aequidens tetramerus*, *Rhamdia sp.*, *Pyrrhulina brevis*, *Callichthys callichthys*, *Gymnotus anguillaris*, *Geophagus jurupari*, *Acarichthys heckelii*, *Crenuchus spilurus*, and *Hemigrammus ocellifer*).

Arachnea

They occurred in *Bryconops inpai*, *Pyrrhulina brevis*, and *Hyphessobrycon bellotti*. The spiders occurred only individually and may be ingested incidentally.

Summarizing the fish species, in respect to a definite food item, already indicates clearly:

— Insect larvae (in 26 species) and vegetable remains (in 26 species) have special share in the diet of fishes. Among each there are some species which feed mainly on insect larvae (9 species) or vegetable remains (4 species).

— Distinct specialists in selection of food do not stand out among the fishes at hand. Indeed, some species ingested a high percentage of certain food items, but this was always accompanied by several other items.

— The number of those species which feed on ants and other terrestrial insects, was large (13 species).

4. Food supply and ingestion in relation to other factors

a) locality

The fishes examined were taken from three different streams. The supply of food could have been correspondingly different. For that reason, the stomach contents of the fishes at hand from two localities are compared (Table 49). It is not of importance here to compare each of the individual food items, but to compare the items (main food) essential to the fishes. It becomes evident that the ingestion was not different, in spite of the localities being limnological differentiated. If in some cases food items were indicated from only one locality, these items always occurred in very small quantities.

b) time of sampling

There is no difference in ingestion related to the different seasons at the time of sampling. The stomach contents of those fishes were caught in May and July 1967 verified rather exactly the results for those fishes from November 1965 (Table 7 + 8, 19 + 20, 24 + 25, 27 + 28, 29 + 30, 31 + 32).

c)' living spaces

The food items which (as shown above) were important with respect to quantity or quality, were found in more or less delineated regions of the waters.

LOCALITIES	INSECT LARVAE 1	2	3	DETRITUS 1	2	3	PLANT REMAINS 1	2	3	CRUSTACEA 1	2	3	FISHES 1	2	3	ANTS 1	2	3
Aequidens tetramerus	●	●		○	○		○	○		○	○		○	○		○	○	
Pyrrhulina brevis	◐	○		○	—		○	○		—	○		○	—		●	●	
Gymnotus anguillaris	●	●		○	—		○	○		○	○		—	○		○	○	
Hyphessobrycon bellotti		◐	◐		—	○		—	○		—	○		—	—		◐	○
Crenicichla saxatilis		◐	●		—	—		○	◐		—	—		◐	○		—	—
Steatogenes elegans		●	●		—	◐		—	○		—	○		—	—		—	—

volume percentage : < 20 % ○ , 20-50 % ◐ , > 50 % ●

localities : 1 = Tarumã , 2 = Barro branco , 3 = Lago Calado

Table 49. Food ingestion in relation to the localities

1. Zone near the surface: ants (other terrestrial insects), possibly fruits and co litter (leafy litter).

2. Zone near or in the stream bottom: sand, insect larvae, detritus, algae, fr coarse litter, Crustacea, and fishes.

The bottom of the stream can be differentiated into two zones: places with gre or lesser accumulations of leaves and detritus, forming the substratum of the ani eaten; and, beds of loose sand (in waters of higher current velocity), in which there only a few possibilities for colonization (Fittkau, 1967).

The zone of stream bottom had greater importance for the fishes, because the stratum, coarse litter and other plant remains, sometimes sand, were eaten.

The area of this zone is enlarged enormously by the exposed roots and branches l in the stream.

When differentiating stream, it has to be considered that the borders of the z are always fluid and consequently cannot be fixed; some food items may be foun several zones of a stream, and others can enter the drift passively, or actively (as fishes

There were also various zones in the stream available to the fishes (Ladiges, 19 The adoption of a certain region is closely related to the ways of life and the shap the fish's body, and — especially important in this paper — there is a relation to the f

Pyrrhulina brevis, judging from its body shape is a fish of the surface region (low b dorsal fin far to the rear, depressed cranium, superior snout, and stronger pectoral f This fish picks up food for the most part in the zone near the surface (ants). Ne theless, additional items from the stream floor were eaten.

Helogenes amazonae also picked up food nearly exclusively at the water surface.

In addition, there are fishes which ingested large percentages of their food from surface (see Table 48 "ants").

Yet most fishes find their food at the bottom. A great many fishes feed on co litter and vegetable remains, and on detritus. Many fishes feed, as well, on insect lar The fishes which mainly feed at the bottom are very different in their ways of life their shape of body. *Gymnotus anguillaris* (e. g.) swims excellently among the maz fallen branches. The small Characidae (*Hemigrammus*, *Hyphessobrycon*) prefer the cur in open waters. Catfishes (*Callichthys*, *Rhamdia*) turn up the coarse litter for food. Cichlidae rove around the maze of fallen branches or range over the outcrops. T shape of body does not indicate clearly their ways of life: the slender, but strong *C cichla* species are, only partly fish-eaters; the high-backed, compressed *Cichlasoma* spe on the other hand, feed on other things besides vegetable remains, fruits, and detr and live among the maze of fallen trees.

Fishes are eaten to a smaller extent, considering the large number of fishes gene present, especially the small species. This may be caused by the fact that the fishe easily able to take refuge in numerous hiding-places. But species recognized as preda by their shape (as in juvenile *Hoplias* or *Crenicichla* species) may pick up large percent of their food from the substrata of the stream bottom. So, one can definitely conc that the fishes, even those which appear to be adapted to certain zones in the stre find their food in the whole living space.

Table 50. Food ingestion (volume percentage) in relation to the age of the fishes (expressed as standard length)

	Hemigrammus ocellifer		*Hyphessobrycon bellotti*		*Pyrrhulina brevis*		*Aequidens tetramerus*		*Geophagus jurupari*		*Callichthys callichthys*		*Gymnotus anguillaris*	
locality	Lago Calado		Barro branco		Tarumã		Tarumã		Lago Calado		Tarumã		Tarumã	
standard length (mm)	< 25 >		< 30 >		< 45 >		< 100 >		< 55 >		< 75 >		< 100 >	
Formicoidea	11	46	16	50	55	59	9	8						
Hymenoptera					4	4								
Isoptera			8	—	1	1								
terr. Coleoptera	7	11			5	11								
Diptera													—	1
Arachnea			9	3										
fruits	11	—							2	10				
coarse litter														
plant matter	32	12			—	4	20	14	34	30	7	9	2	8
chitinous remains	2	7	25	17	1	4			20	20				
detritus	12	10							27	18	7	2	6	4
aquat. Coleoptera	4	—									—	2		
Hemipteroidea	7	—			—	2								
— larvae — Ephemeroptera	1	15	41	16	16	9	24	14			3	20	19	32
Odonata	—	4					—	8					4	—
Trichoptera			2	—			24	16			30	29	38	44
Lepidoptera														
Coleoptera	2	—			—	2	3	2						
Diptera			—	3	6	—	16	4	6	3	28	10	24	5
sand	3	—												
algae							—	6						
Hydracarina	—	2			1	—	3	—						
Crustacea	6	—					6	13	24	17	8	6		
fishes					—	3	1	9	4	3	3	—		

d) age of fishes

Some fish species, those present in sufficient number were examined to determine changes in the food ingested occur with age (expressed as standard length), Table 50. It must be noted, that the very youngest individuals were not present. In this table the mean (volume) percentages of food were calculated again, roughly, based on smaller number of specimens. Differences less than 10% are not discussed.

From this it was determined that species which do not prefer (main food) a single food item, exhibit a change in food ingested, in relation to increasing standard length (Table 51).

Those species with a main food (*Pyrrhulina brevis* and *Geophagus jurupari*) do not indicate this change. In *Aequidens tetramerus* no distinct change is to be noted, but the large specimens show even more variation in food ingested, with no special preference.

These differences in food with age do not merit closer consideration in this essentially limnological paper.

Table 51. The change in foods ingested in relation to increasing standard length (see text)

	small	large
Hemigrammus ocellifer	plant matter, fruits	ants, Ephemeroptera larvae
Hyphessobrycon bellotti	Ephemeroptera larvae	ants
Aequidens tetramerus	Ephemeroptera larvae chironomid larvae	—
Callichthys callichthys	chironomid larvae	Ephemeroptera larvae
Gymnotus anguillaris	chironomid larvae	Ephemeroptera larvae
Pyrrhulina brevis	ants	ants
Geophagus jurupari	plant matter, fruits	plant matter, fruits

5. Summarizing the results on stomach contents

The stomach contents were discussed from various points of view. The result of these investigations can be listed as follows:

— Insect larvae and vegetable remains are essential to the diets of the fishes.

— The number of those species ingesting ants (and other terrestrial insects) was large (13 species).

— Distinct specialists in food ingestion are not present in the material examined.

— The stomach contents of the various families were rather uniform, because most species indicate a more or less great variability in food selected.

— Neither the structure of the snout and denture, nor the morphological structure of the alimentary canal, nor even the intestinal ratio can be used as indices to the feeding habits.

— The ingestion of food was not different in spite of limnologically differentiated localities, nor were the stomach contents related to the time of sampling (May, July, and November).

— The fishes find their food in the whole living space, even those fishes which appear to be adapted to certain zones in the stream.

— Differentiation in stomach contents according to age of the fishes did not merit close consideration.

Limnological Interpretation of the Results

From a limnological standpoint, it has been asked: What do the fishes feed on in the streams of the terra firme? It must be answered by coordinating the results presented with the many factors which influence the form of the Amazon landscape.

It would be premature to accept, so soon, the influence of single factors as positively known, because, the interdependence of those factors is only beginning to be understood. If one must decide on the influence of single known data on the whole complex, it must always be clear, that this is an interpretation of only one of the possible effects.

Up to now, studies of the chemistry of the waters, expressing the geological, climatical, and soil conditions of the landscape, have taken high rank in limnological papers (SIOLI, FITTKAU, KLINGE, BRAUN).

The small quantities of soluble minerals found in the waters, together with other chemical, physical and zoological data, suggested that the Amazon region was a poor biotope, compared to temperate regions. Now, in the knowledge of the food of series of fishes, another factor is given whose role in the interdependent fluctuations of waters and landscape can only be interpreted for the time being. This factor allows some considerations, now, which could be go beyond the existing conceptions about the Amazon region.

In the creeks, again and again, large numbers of fishes were counted. All were able to find sufficient food.

The stomachs examined were only seldom without contents (Table 5). Consequently, one may not say that the fishes lived in poverty, in the sense of lacking food.

The food is available in all zones of the waters. So the fishes are continually able to find the food, wherever they find themselves. And they are able, as shown by the anatomical considerations, to pick up the various food items, whether they are plant matter, larvae, or fishes.

Food items from the surface and the bottom can be found in the same stomach. The fishes are apparently not chained to a certain zone in the creek regarding food. Everywhere, food is available to the fishes. Even in the course of a year, no differences in the supply of food are indicated, as shown by the material from May, July, and November.

There are no distinct specialists judging from their food, among the fishes examined. This fact may be taken as an expression of the fishes' ability to make use of other food sources when the prefered food items are in short supply.

With this fact, one can also argue that the supply of food is so adequate, that the fishes are not in vital competition for it.

A great variety of species is often observed even in small sections of the creeks. Different species occur together in swarms and are of striking similarity. It has not proved necessary to the species to specialize for food, neither in that special morphological abilities must be established, nor that any special food must be selected. So it is no surprise when the material examined lacked distinct specialists. In addition, it was not necessary for many species to keep to a limited living space to protect the food against others. The food factor has had little selective influence on the fish species in the central Amazon region.

The great variety of these primitive forms, particularly apparent in the Characidae, may indicate this.

In other waters where species have developed great variety as, e. g., the old African lakes with their large number of endemic fishes, the food also occurs in sufficient amounts (LADIGES, 1968). By this indication that great variety is, indeed, related to sufficient supply of food, nothing is said about the reasons for speciation. This must be discussed further (TREVAWAS, 1947, FRYER, 1959, KOSSWIG, 1947, 1963).

Aquatic insect larvae are essential to the diets of fishes. Among them, there are few chironomids, but many Ephemeroptera and Trichoptera. This result is surprising, because in the creeks, the small population densities observed, up to now, (FITTKAU, 1964, 1967), do not appear able to support the many fishes. In addition, it is also surprising that the percentage of vegetable remains is so large, especially the percentage of coarse litter. Earlier reports that leafy litter which drops into the water does not enter (or only enter after a long time) the nutrition cycle, or, that the leafy litter have no nutritional value, must be critically re-investigated. (KAUSHIK & HYNES, 1968, examined the nutritional value of the leafy litter in British rivers and rivulets).

These two food items indicate that when working with temporally limited data, just as in determinations of biomass or density of a polpulation, one obtains only a momentary view which does not reveal much about the capacity, productivity, or the yield of fertility of a biotope. (This biotope is primarily characterized by its large turn over). Consequently, one speaks only of a sufficient supply of food.

It is to be expected that the supply exists in the same quantity over the whole year. It may be differently composed in quality, but there are always larvae, leaves continuously drop from the trees, there are always ant-species falling into the water, and there are fishes always enough present which can be eaten. In the course of the year there is no time of dormancy or period of simply surviving.

This biotope does not even depend on the annual oscillations characterictic of rivers in the Amazon region.

In contrast, investigations in regions of seasonal changes, as in the savannah district of British Guiana (LOWE (MCCONNELL), 1964), where many fishes take refuge in the few remaining ponds and rivulets during dry season, allow the conclusion that food is limiting. (It was observed that many fishes had utilized their entire chshion of fat at the end of the dry season, that the number of fish predators was relatively enlarged, and that the number of small characids has conspicuously decreased.)

The terra firme creeks retain striking continuity of their ecological conditions over the whole year. This permits the biological communities to live permanently in balance,

meaning that sufficient food is avaiable to a certain determined density of fish, which is usually very large.

Acknowledgements

With deep gratitude, I acknowledge the valuable guidance and help which I received from Prof. H. Sioli, Director of the Department of Tropical Ecology, Max-Planck-Institut für Limnologie in Plön. I am also grateful to Dr. E.-J. Fittkau (Plön), Dr. R. Geisler (Freiburg), Dr. J. Géry (Les Eyzies, France), and W. Junk (Plön) for fruitfull discussions on the problems occuring in the Amazon region. I thank Dr. S. C. Mozley for assisting me in my English translation. Thanks are due to the Max-Planck-Gesellschaft z. F. d. W. for financial assistance.

Summary

In the year 1965 and, in addition, in the year 1967 more than 3200 fish specimens could be collected in rain-forest-streams of the central Amazon region. From them, the stomach contents of 1296 fishes were examined.

In 49 fish species (22 Characoidei, 6 Gymnotoidei, 3 Siluriformes, 1 Rivulidae, and 16 Cichlidae) the stomach contents were enumerated by the number method, the volume method, and the occurrence method.

The food supply was characterized by 24 food items differentiated.

These stomach contents were discussed from various points of views.

Insect larvae and vegetable remains were essential to the diets of the fishes.

The number of those species ingesting ants (and other terrestrial insects) was large (13 species).

Distinct specialists in food ingestion are not present in the material examined.

The stomach contents of the various families were rather uniform, because most species indicate a more or less great variability in food selected.

Neither the structure of the snout and denture, nor the morphological structure of the alimentary canal, nor even the intestinal ratio can be used as indices to the feeding habits. The ingestion of food was not different in spite of limnologically differentiated localities, nor were the stomach contents related to the time of sampling (May, July, November).

The fishes find their food in the whole living space, even those fishes which appear to be adapted to certain zones in the stream.

Differentiation in stomach contents according to age of fishes did not merit close consideration.

In the knowledge of the food of a series of fishes another factor was given whose role in the interdependent fluctuations of waters and landscape can only be interpreted for the being time.

The food supply was interpreted as sufficient related to the results of the investigations of stomach contents and other tropical conditions of the central Amazon region.

Resumo

O presente trabalho comunica o exame de conteúdos estomacais de 1296 peixes, coletados em igarapés da Amazônia Central nos anos de 1965 e 1967. Por contagem dos individuos encontrados nos estômagos dos peixes, como por avaliação da porcentagem volumétrica dos componentes dos alimentos ingeridos e pela frequência dos mesmos, analisaram-se quantitativamente os conteúdos estomacais, e pela distinção de 24 componentes alimentares diferentes verificouse qualitativamente a alimentação dos peixes. Discutem-se antão os conteúdos estomacais sob diversos pontos de vista.

Larvas de insetos e restos vegetais são essenciais para a alimentação dos peixes. É grande o número de espécies (13) em cujos estômagos se encontram formigas (e/ou outros insetos aéreos). Não aparecem, entre os peixes examinados, especialistas pronunciados na escolha de alimento. Os conteúdos estomacais nas diversas famílias são de uma certa uniformidade, sendo que a maioría das espécies de peixes mostras um espetro ± largo na escolha dos componentes da alimentação.

A formação da boca, da dentadura es dos dentes, do trato estomacalintestinal, e o comprimento relativo do intestino não podem ser utilizados como indício da ecologia alimentar.

A alimentação dos peixes é uniforme apesar de localidades limnologicamente diferentes; tão pouco é a época (estação do ano) da coleta que influe sôbre a composição dos conteúdos estomacais. Os peixes, mesmo parencendo adaptados a um certo biótopo, encontram o seu alimento em todo o corpo d'água. Não é possivel uma diferenciação dos conteúdos estomacais em relação à idade dos peixes. O conhecimento dos alimentos de uma série de peixes revela um fator cujo papel, no jogo das interrelações mútuas entre corpo d'água e paisagem, pode ser, até então, somente comunicado como uma contribuição à discussão.

Baseado em alguns argumentos deduzidos da situação geológico-geográfica e das condições tropicais da região central-amazônica, a oferta de alimento é interpretada como sendo suficiente.

List of fishes examined

Acarichthys heckelii MÜLLER & TROSCHEL 1848
Acaronia nassa (HECKEL 1840)
Acestrorhynchus falcatus (BLOCH 1794)
Aequidens tetramerus (HECKEL 1840)
Ancistrus sp.
Apistogramma agassizii (STEINDACHNER 1875)
Brycon melanopterus (COPE 1871)
Bryconops affinis (GÜNTHER 1864)
Bryconops inpai KNÖPPEL, JUNK, GERY 1968
Callichthys callichthys LINNÉ 1758
Chaetobranchus flavescens HECKEL 1840
Chilodus punctatus MÜLLER & TROSCHEL 1844
Cichla ocellaris BLOCH & SCHNEIDER 1801
Cichlasoma festivum (HECKEL 1840)
Cichlasoma severum (HECKEL 1840)
Copella nattereri (STEINDACHNER 1875)
Crenicichla johanna HECKEL 1840
Crenicichla lugubris HECKEL 1840
Crenicichla nanus REGAN 1913
Crenicichla notophthalmus REGAN 1913
Crenicichla ornata REGAN 1905
Crenicichla saxatilis (LINNÉ 1758)
Crenuchus spilurus GÜNTHER 1863
Curimatus latior (SPIX 1829)
Curimatus spilurus GÜNTHER 1864
Eigenmannia macrops (BOULENGER 1897)
Geophagus jurupari HECKEL 1840
Gymnorhamphichthys hypostomus ELLIS 1913
Gymnotus anguillaris HOEDEMANN 1962
Gymnotus carapo LINNÉ 1758
Helogenes amazonae DELSMAN 1941
Hemigrammus ocellifer (STEINDACHNER 1882)
Hoplerythrinus unitaeniatus (SPIX 1829)
Hoplias malabaricus (BLOCH 1794)
Hyphessobrycon bellotti (STEINDACHNER 1883)
Iguanodectes tenuis COPE 1871
Leporinus friderici (BLOCH 1794)
Loricaria sp.
Megalamphodus micropterus EIGENMANN 1915
Moenkhausia ceros EIGENMANN 1908
Moenkhausia lepidura (KNER 1859)
Monocirrhus polyacanthus HECKEL 1840
Poecilobrycon eques (STEINDACHNER 1876)
Poecilobrycon unifasciatus (STEINDACHNER 1876)
Prochilodus theraponura FOWLER 1906
Pseudancistrus sp.
Pterygoplichthys sp.
Pyrrhulina brevis STEINDACHNER 1875
Rhamdia sp.
Rivulus "urophthalmus"
Steatogenes elegans STEINDACHNER 1880
Sternopygus macrurus (BLOCH & SCHNEIDER 1801)
Uaru amphiacanthoides HECKEL 1840

References

ALEXANDER, R. Mc. N. (1964): Adaptation in the skulls and cranical muscles of South American characoid fish; Journal Linn. Soc. (Zool.) **45** (305), 169—190.

ALEXANDER, R. Mc. N. (1966): Structure and function in the catfish; Journal of Zoology, London **148** (1), 88—152.

AZEVEDO, P. DE, DIAS, M. V. & B. B. VIEIRA (1958): Biologia do saguirú (Curimatidae); Memorias do Instituto Oswaldo Cruz **33** (4), 481—553.

BERG, L. S. (1958), System der rezenten und fossilen Fischartigen und Fische; Berlin, 310 pp. (2nd edition, 1955).

BÖHLKE, J. E. (1958): A report on several extensive recent collections from Ecuador; Proc. Acad. Nat. Sci. Philadelphia, **110**, 1—121.

BRAUN, R. (1952): Limnologische Untersuchungen an einigen Seen im Amazonasgebiet; Schweizerische Ztschr. Hydrol. **14**, 1—128.

CORBET, P. S. (1961): The food of non-cichlid fishes in the Lake Victoria basin, with remarks on their evolution and adaption to lacustrine conditions; Proc. Zool. Soc. London **136**: 1—101.

DELSMAN, H. C. (1941): Resultats scientifiques des croisieres du navire-école Belge "Mercator", Vol. III—Pisces; Mem. Mus. Roy. Hist. Nat. Belgique ser. 2, **21** (3), 86.

EIGENMANN, C. H. (1912): The fresh-water fishes of British Guayana, including a study of ecological grouping of species and the relationships of the fauna of the plateau to that of the lowlands; Mem. Carnegie Museum **5** (67), 1—578, 103 pls.

EIGENMANN, C. H. (1915): The Cheirodontinae, a subfamily of minute characid fishes of South America; Mem. Carnegie Museum **7** (1), 1—99, 17 pls.

EIGENMANN, C. H. (1918): The Pygidiidae, a family of South American catfishes; Mem. Carnegie Museum **7** (5), 258—398.

EIGENMANN, C. H. (1925): A review of the Doradidae; Trans. Americ. Philos. Soc. **21**, 280—365, 27 pls.

EIGENMANN, C. H. & G. S. MYERS (1917/1929): The American Characidae (part 1—5); Mem. Mus. Comp. Zool. Harvard **43**, 1—529.

ELLIS, M. M. (1913): The gymnotid eels of tropical America; Mem. Carnegie Museum **6** (3), 109—195.

FITTKAU, E. J. (1964): Remarks on limnology of central-Amazon rain-forest-streams; Verh. Internat. Verein. Limnol. **15**, 1092—1096.

FITTKAU, E. J. (1967): On the ecology of Amazon rain-forest-streams; Atas do Simpósio sobre a Biota Amazonica **3** (Limnologia), 97—108.

FOWLER, H. W. (1948/1954): Os peixes de agua doce do Brasil; Arq. Zool. Est. Sao Paulo **6** (1—3), 1—628; **9**, 1—400.

FRYER, G. (1959): The trophic interrelationships and ecology of some littoral communities of Lake Nyassa with especial reference to the fishes, and a discussion of the evolution of a group of rock-frequenting Cichlidae; Proc. Zool. Soc. London, **132**, 151—281.

GEISLER, R. (1967): Zur Limnochemie des Igarapé Préto; Amazoniana **1** (2), 117—123.

GEISLER, R. (1967a): Linmologisch-ichthyologische Beobachtungen in SW-Ceylon; Int. Rev. ges. Hydrobiol. **52** (4), 559—572.

GEISLER, R. (1969): Untersuchungen über den Sauerstoff-Gehalt, biochemischen Sauerstoff-Bedarf und Sauerstoff-Verbrauch auch von Fischen in einem tropischen Schwarzwasser (Rio Negro, Amazonien); Archiv Hydrobiol., **66** (3), 307—325.

GEISLER, R. & S. BOLLE (1956): Nahrungsuntersuchungen an nordargentinischen Wildfischen; Deutsche Aquarien- u. Terrarienzeitschrift **9** (8), 208—213.

GERY, J. (1960a): New Cheirodontinae from French Guiana; Senck. biol. **41** (1/2), 15—39.

GERY, J. (1960b): Validité de *Leporinus despaxi* PUYO et sousgenre *Hypomasticus* BORODÏN; Bull. Mus. nat. Hist. nat. 2ser. **32** (3), 22—229.

GERY, J. (1960c): Un nouveau sous-genre de *Leporinus* (Erythrinidae, Anostominae), *Leporinops*, type *Leporinus moralesi*. Bull. Mus. Nat. Hist. nat. 2ser. **32** (4), 308—318.

GERY, J. (1961): Structures et évolution des Anostominae; Bull. of Aquatic Biology (Amsterdam) **2** (19), 93—112.

GERY, J. (1963a): Paired frontal foramina in living teleosts: Definition of a new family of characoid fishes, the Crenuchidae; Nature **198** (4879), 502—503.

GERY, J. (1963b): *Copella vilmae* n. sp. (Pisces, Characoidei); Senck. biol. **44** (1), 25—31.

GERY, J. (1963c): Three new tetras from the Upper Rio Negro near Tapurucuara; Tropical Fish Hobbyist **12** (3), 9, 11, 13, 15,57—59, and 62—63.

GERY, J. (1964a): A review of the Chilodinae, with a key to the species; Tropical Fish Hobbyist **12** (9), 5—10 et 63—67.

GERY, J. (1964b): Poissons characoides de l'Amazonie peruvienne; Beitr. Neotrop. Fauna **4** (1), 1—44.

GERY, J. (1965a): Characidae et Crenuchidae de l'Igarapé Préto; Senck. biol. **46** (1), 11—45.

GERY, J. (1965b): Notes on characoid fishes collected in Surinam by Mr. H. P. Pijpers, with descritions of new forms; Bijdragen tot de Dierkunde **35**, 101—126. (rec. 1966.)

GERY, J. & VU-TAN-TUE (1964): *Gymnorhamphichthys hypostomus petiti ssp. n.* un çuriux poisson Gymnotide Arenicole; Vie et Milieu, suppl. **17**, 485—498.

GNERI, F. S. & V. ANGULESCU (1951): La Nutricion de los Peces iliofagos; Revista d. Instit. nac. de Investigacion d. l. ciencas naturales, Ciencia Zoolog. **2** (1).

GOSLINE, W. A. (1966): Comments on the classification of the percoid fishes; Pacific. Sci. **20** (4), 409—418.

GREENWOOD, ROSEN, WEITZMANN & MYERS (1966): Phyletic studies of teleostean fishes, with a provisional classification of living forms; Bulletin American Museum Nat. Hist. **131** (4), 339—456.

GREGORY, W. K. (1933): Fish skulls, a study of the evolution of natural mechanisms; Trans. Americ. Phil. Soc. **23** (2), (reprint 1959).

GREGORY, W. K. & CONRAD, G. M. (1938): The phylogeny of the Characin fishes; Zoologica (New York) **23**, 319—360.

HARDER, W. (1960): Vergleichende Untersuchungen zur Morphologie des Darmes bei Clupeoidea; Z. wiss. Zool. **63**, 65—167.

HARDER, W. (1964): Anatomie der Fische; Handbuch d. Binnenfischerei Mitteleuropas Bd. 2a, b.

HIRSCH, G. C. (1950): Magenlose Fische, Versuche einer Typenmäßigen Erklärung; Zool. Anzeiger, Erg. Band zu **145**, 302—326.

HYNES, H. B. N. (1950): The food of fresh-water stickle backs (*Gasterosteus aculeatus* and *Pygosteus pungitius*) with a review of methods used in studies of the food of fishes; Journal Animal Ecology **19**, 36—58.

JACOBSHAGEN, E. (1911/1915): Untersuchungen über das Darmsystem der Fische und Dipnoi; Jenaische Zeitschrift f. Naturwissenschaft **47**, 529, (1911). **49**, 345, (1913). **53**, 373, (1915).

KAUSHIK, N. K. & H. B. N. HYNES (1968): Experimental study on the role of autumn shed leaves in aquatic environments; Journal Ecology (Oxford) **56**, 229—243.

KLINGE, H. (1965): Podzol Soils in the Amazon Basin; Journ. Soil Science (Oxford) **16** (1), 95—103.

KLINGE, H. (1967): Podzol soils: A source of Blackwater rivers in Amazonia; Atas do Simposio sobre a Biota Amazonica 3, 117—125.

KNÖPPEL, H. A., JUNK, W. & J. GERY (1968): *Bryconops* (*Creatochanes*) *inpai*, a new characoid fish from the central Amazon region, with a review of the genus *Bryconops*; Amazoniana **1** (3), 231 to 246.

KOSSWIG, C. (1947): Selective mating as a factor for speciation in cichlid fish of East African lakes; Nature **159**, 604—605.

KOSSWIG, C. (1965): Ways of speciation in fishes; Copeia **2**, 238—244.

LADIGES, W. (1950): Wovon ernähren sich unsere Fische in der Freiheit?; Wochenschrift Aquarien- u. Terrarienkunde **44**, 330—332.

LADIGES, W. (1951): Der Fisch in der Landschaft; Braunschweig, 2nd edition, 182 pp.

LADIGES, W. (1968): Die Bedeutung ökologischer Faktoren für die Differenzierung der Cichliden des Tanganyika- und des Njassa Sees; Int. Rev.ges. Hydrobiol. **53** (2), 339—352.

LOWE, (McConnell) R. H. (1964): The fishes of the Rupununi savanna district of Brit. Guiana (1) Ecological groupings of species and effects of the seasonal cycle on the fish; Journal Linn. Soc. (Zool.) **45** (304), 103—144.

LÜLING, K. H. (1961): Fischbeobachtungen am Rande eines Schwarzwasserflusses im peruanischen Amazonasdistrikt; Aquarien und Terrarien **8** (11), 327—335.

LÜLING, K. H. (1963/64): Die Quisto Cocha und ihre Fische; Beitr. Neotrop. Fauna 3, 34—56.

MARLIER, G. (1967): Ecological studies on some Lakes of the Amazon valley; Amazoniana **1** (2), 91—113.

MENEZES, R. S. (1948): Listas dos nomes vulgáes de peixes; Arquivos Museu Nacional **42**, 343—388.

MENEZES, R. S. (1961): Notas sobre a alimentação do jacunda "*Crenicichla saxatilis*"; Bol. Söc. Cear. Agron. **2**, 51—53.

MYERS, G. S. (1929): On curimatid Characin fishes having an incomplete lateral line, with a note on the peculiar sexual dimorphism of *Curimatopsis macrolepsis*; Ann. Mag. Nat. Hist. 3, 10 ser., 618—623.

MYERS, G. S. (1960): Fish evolution in Lake Nyassa; Evolution **14** (3), 394—396.

NIJSSEN, H. & I. J. H. ISBRÜCKER (1968): *Gymnotus carapo* and *G. anguillaris*, two often confused species of gymnotid fishes; Beaufortia (Amsterdam) **15** (203), 161—168.

PETR, T. (1967): Food preferences of the commercial fishes of the Volta lake; University of Ghana, Volta Basin Research Projekt Technical Report X 22.

RANDOW, H. (1951): Zur Ernährung tropischer Süßwasserfische in ihrem Heimatgebiet; Deutsche Aquarien- u. Terrarienzeitschrift, 126.

RAUTHER, M. (1911): Beiträge zur Kenntnis der Panzerwelse; Zool. Jahrb. Abt. Anatomie u. Ontologie **31**, 497—528.

REGAN, C. T. (1905a): Revision of the fishes of the South American cichlid genera *Acara*, *Nannacara*, *Acaropsis*, *Astronotus;* Ann. Mag. Nat. Hist. London 7 ser. **15**, 329—347.

REGAN, C. T. (1905b): A revision of South American genera *Crenicara*, *Batrachops*, *Crenicichla;* Proc. Zool. Soc. London **1**, 152—168.

REGAN, C. T. (1905c): A revision of the fishes of the American cichlid genus *Cichlasoma* and the allied genera; Ann. Mag. Nat. Hist. London 7ser. **16**, 66—77, 225—243, 316—340, and 433—445.

REGAN, C. T. (1906): A revision of the South American cichlid genera *Retroculus*, *Geophagus*, *Heterogramma*, *Biotoecus;* Ann. Mag. Nat. Hist. London 7ser. **17**, 49—66.

ROBERTS, T. R. (1967): Tooth formation and replacement in characoid fishes; Stanford Ichtyol. Bulletin **8** (4), 231—247.

ROWNTREE, W. S. (1903): On some points in the visceral anatomy of the Characinidae, with an enquiry into the relations of the ductus pneumaticus in the Pysostomi generally; Trans. Linn. Soc. London 2ser. **9**, 47—81.

ROWNTREE, W. S. (1906): On the dentition of the characoid genus *Piabuca:* a new generic character; Ann. Mag. Nat. Hist. 7ser. **17**, 240—243.

SIOLI, H. (1950): Das Wasser im Amazonasgebiet; Forschung u. Fortschritte, (Berlin) **26** (21/22), 274—280.

SIOLI, H. (1957): Beitrag zur regionalen Limnologie des Amazonasgebietes IV -Limnolog. Untersuchung in der Region der Eisenbahnlinie Bélem—Bragança (Pará); Archiv Hydrobiol. **53**, 161—222.

SIOLI, H. (1965): Bemerkungen zur Typologie amazonischer Flüsse; Amazoniana **1** (1), 74—83.

SIOLI, H. & H. KLINGE (1961): Über Gewässer und Böden des brasilianischen Amazonasgebietes; Die Erde (Berlin) **92**, 205—219.

SCHNAKENBECK, (1955): Pisces; in: Handbuch der Zoologie Bd. 6, 1. Hälfte, 7. Lief.

STEINDACHNER, F. (1875): Beiträge zur Kenntnis der Characinen des Amazonenstrom; Sitzb. k. Akad. Wiss. Wien, math.-natur. Klasse, **72**, 6—24.

STERBA, G. (1959): Süßwasserfische aus aller Welt; Berchtesgaden, 638 pp.

TRAVASSOS, H. u. S. Y. PINTO (1958): Estudos sobre a familia Cichlidae I; Boletim do Museu Nacional, Zoologia **175**, 1—9.

TREVAWAS, E. (1947): Speciation in cichlid fishes of East African lakes; Nature **160**, 96—97.

WEITZMAN, S. H. (1954): The osteology and relationships of the South American characin fishes of the subfamily Gasteropelecinae; Stanford Ichthyol. Bulletin **4** (4), 233—263.

WEITZMANN, S. H. (1962): The osteology of "*Brycon meeki*", a generalized characid fish, with an osteological definition of the family; Stanford Ichthyol. Bulletin **8** (1), 1—77.

WEITZMAN, S. H. (1966): Review of South American characid fishes of the subtribe Nannostominae; Proc. US Nat. Mus. **119** (3538), 1—56.

WUNDER, W. (1936): Physiologie der Süßwasserfische; Handbuch der Binnenfischerei Mitteleuropas Bd. 2b.

ZIMMERMANN, M. (1967): Photometrische Metall- und Wasseranalysen mit Filterphotometern und mit Spektralphotometern; 3rd edition, Stuttgart.

Author's Adress:

Dr. Hans-Armin Knöppel
Max-Planck-Institut für Limnologie
Abteilung Tropenökologie
D-2320 Plön (Holst.)
Fed. Rep. Germany